



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

REGION 5
77 WEST JACKSON BOULEVARD
CHICAGO, IL 60604-3590

REPLY TO THE ATTENTION OF: SR-6J

April 25, 2011

Mr. Patrick Steerman
Steerman Environmental Management & Consulting, LLC
422 Creek View Lane
Roswell, GA 30075

Re: Chemical Recovery Systems Inc. Site
Comments on Additional Groundwater Studies Work Plan

Dear Mr. Steerman:

On March 31, 2011, the U.S. Environmental Protection Agency (EPA) and Ohio Environmental Protection Agency (OEPA) received the additional groundwater studies work plan (AGWS) from Steerman Environmental Management & Consulting, representing the Chemical Recovery Systems Remedial Design/Remedial Action Group Performing Parties. Following are questions and comments from the Agencies on the plan.

EPA-OEPA comments

1. The purpose and scope of the investigation needs to be clear throughout the document, such that gathering further evidence to support monitored natural attenuation, defining the plume's extent, investigating contaminant migration under the river, and the vapor intrusion pathway (and migration) should be acknowledged. (Please see Record of Decision page 12, 13; Statement of Work page 5).

2. Why was there was no mention of continuing the investigation across the river if data show the need for this? If information collected on-site warrants further investigation across the river, it will be evaluated in a phased manner consistent with the requirements of the statement of work. For example, what are potential decision criteria for installation of wells H-G and I-J?

OEPA comments

1. The Sampling Plan (FSP), Quality Assurance Project Plan (QAPP), and Health and Safety Plan (HASP) were included as Appendices A - C on compact disks. The disks were blank in the document [Larry Anotonelli] received. The work plan states that these plans are from the RD Work Plan. Were the plans tailored to the work proposed in the AGWS?

2. It is thought that compounds in soil are consistent with past operations of the Municipal Gas Plant (MGP). (Namely for semi-volatile organic compounds (SVOCs)). When was a MGP as a possible contributor to site contamination discovered or mentioned previously?

3. On page 3-2 (mid-page), the consultant mentions a monitoring well 10 (MW10) cluster. I was unable to locate a MW10 on the site figures. There is a GP10 location, but it is not a cluster of any sort. If it was meant to describe the proposed MW-XA, B, C or MW-7A, B, C locations this should be clarified—as implied on page 3-3 of the work plan.

We would like to set up a call to talk about the work plan and comments soon. If you have any questions or concerns, please contact me at (312) 886-8961.

Sincerely,

A handwritten signature in black ink, appearing to read "Michelle Kerr". The signature is fluid and cursive, with the first name "Michelle" written in a larger, more prominent script than the last name "Kerr".

Michelle Kerr
Remedial Project Manager

cc via email: L. Antonelli, OEPA
L. Mencin, Sherwin Williams
J. Peeples, B&C

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June 3, 2011

Brown AND
Caldwell

Ms. Michelle Kerr
Remedial Project Manager
United States Environmental Protection Agency
Region 5
77 West Jackson Boulevard
Chicago, IL 60604-3590

5030/139452-310
SID # 23428

Subject: Response to Comments on the Additional Groundwater Studies Work Plan
United States of America v. AK Steel Corporation et. Al.
Case No. 1:10-cv-00996-KMO
Chemical Recovery System Superfund Site, Elyria, Ohio, Inc. Site

Dear Ms. Kerr:

Please find outlined below responses to the comments you provided on April 25, 2011 following your review of the Additional Groundwater Studies (AGWS) Work Plan you received from Steerman Environmental Management & Consulting, on behalf of the Chemical Recovery Systems Remedial Design/Remedial Action Group Performing Parties (CRS Performing Parties). Your comments are provided below indented, italicized, and numbered and are followed by specific responses from the CRS Performing Parties. A red-line version of the report text is provided so you can see how the changes were implemented. When all changes are final, a final electronic version of the Work Plan will be provided along with hard copies of all pages that have been changed (for insertion into your existing hard copy of this report).

EPA-OEPA Comments

1. *The purpose and scope of the investigation needs to be clear throughout the document, such that gathering further evidence to support monitored natural attenuation, defining the plume's extent, investigating contaminant migration under the river, and the vapor intrusion pathway (and migration) should be acknowledged. (Please see Record of Decision page 12, 13; Statement of Work page 5).*

Response

Section 1.1 and the second introductory paragraph of Section 3 of the AGWS Work Plan has been updated to include language that makes the purpose and scope of the additional work more clear and consistent. Please see changes on pages 1-1 and 3-1 of the attached redline version of the AGWS Work Plan for the incorporated changes.

2. *Why was there was no mention of continuing the investigation across the river if data show the need for this? If information collected on-site warrants further investigation across the river, it will be evaluated in a phased manner consistent with the requirements of the statement of work. For example, what are potential decision criteria for installation of wells H-G and I-J?*

Response

Additional language was added to the AGWS Work Plan stating that data collected as a part of the AGWS will be used to determine if cross-river transport of contaminants from the CRS Site is possible or probable.

The AGWS Work Plan text has been updated on pages 3-5 and 3-6 to include this. The text does not indicate specific locations of monitoring points or wells that would be placed on the downgradient (west) side of the river if cross-river transport is determined to be probable. If that is the case, BC will develop a new work plan that incorporates information gained from implementing the AGWS, and provides the means and methods to evaluate 1) if COCs have migrated west in bedrock under the river, and 2) whether a completed pathway from exposure to soil vapor exists.

OEPA Comments

1. *The Sampling Plan (FSP), Quality Assurance Project Plan (QAPP), and Health and Safety Plan (HASP) were included as Appendices A -C on compact disks. The disks were blank in the document [Larry Anotonelli] received. The work plan states that these plans are from the RD Work Plan. Were the plans tailored to the work proposed in the AGWS?*

Response

New disks were provided to OEPA and confirmation was received that the disks contain the appropriate documents.

2. *It is thought that compounds in soil are consistent with past operations of the Municipal Gas Plant (MGP). (Namely for semi-volatile organic compounds (SVOCs)). When was a MGP as a possible contributor to site contamination discovered or mentioned previously?*

Response

Indications were present at the time of the Remedial Investigation/Feasibility Study (RI/FS) that the CRS Site previously contained a manufactured gas plant (MGP). The Sanborn maps indicated MGP activity as early as 1878. The 2010 sampling events of monitoring well MW-6 provided an indication that some of the Site impact in soil and groundwater may be a result of MGP activities. A naphthalene odor was noted at MW-6, and naphthalene (a well known chemical associated with MGPs) was a significant contaminant in both free (NAPL) and dissolved (groundwater) phases from 2010 samples collected at this location. Other SVOCs and VOCs were also noted during the analytical that might point to a MGP source for some of the observed soil and groundwater impact.

3. *On page 3-2 (mid-page), the consultant mentions a monitoring well 10 (MW10) cluster. I was unable to locate a MW10 on the site figures. There is a GP10 location, but it is not a cluster of any sort. If it was meant to describe the proposed MW-XA, B, C or MW-7A, B, C locations this should be clarified-as implied on page 3-3 of the work plan.*

Response

The reference to MW-10 was a typographical error. The referenced location has been changed to correctly identify the new well in the MW-6 area as the example well for placement of all new wells in areas where NAPL is encountered or suspected.

Please let me know if you have any questions regarding these responses or AGWS Work Plan. The responses were incorporated in the AGWS Work Plan redline version that is attached. When the plan is approved as final, the changed text will be accepted and a clean version of the electronic file will be provided and final change pages for the hard copies will also be provided.

Very truly yours,

Brown and Caldwell



James Peebles
Project Manager

cc: L. Antonelli, OEPA
L. Mencin, Sherwin Williams
Patrick Steerman, Steerman Environmental Management & Consulting
Douglas McWilliams, Squire, Sanders, and Dempsey, LLC

Attachments (1)

Additional Groundwater Studies Work Plan

Prepared for
CRS Site RD/RA Performing Parties
Chemical Recovery Systems, Inc. (CRS) Site
Elyria, OH
March 2011
Revised June 2011

Additional Groundwater Studies Work Plan

Prepared for
CRS Site RD/RA Performing Parties
Chemical Recovery Systems, Inc. (CRS) Site
Elyria, OH
March 2011
Revised June 2011

139452



4700 Lakehurst Court, Suite 100
Columbus, Ohio 43016

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Section 1

Introduction

This Additional Groundwater Studies (AGWS) Work Plan is submitted on behalf of the Chemical Recovery Systems, Inc. (CRS) Site RD/RA Group Settling Performing Defendants in the CRS RD/RA Group (the Performing Parties) to meet a requirement of the Consent Decree United States of America v. AK Steel Corporation et al., Case No. 1:10-cv-00996 (CD), signed by U.S. Environmental Protection Agency (USEPA) and the Performing Parties, and entered by the Court on July 16, 2010, the Record of Decision (ROD), and the Statement of Work (SOW), for the CRS Site (Site). This AGWS Work Plan provides details regarding the installation of borings and wells and other work necessary to meet the requirements specified in the SOW. This AGWS Work Plan also includes additional investigative work that the Performing Parties have elected to complete which will further characterize the nature and extent of impacts in the bedrock and provide information necessary for completion of the Remedial Design (RD).

The objective of the RD is to prepare plans and specifications for the implementation of the Remedial Action (RA) at the Site that meet requirements specified in the ROD, SOW, and CD. The objective of this AGWS Work Plan is to provide additional information regarding the nature and extent of groundwater impact and to meet the conditions detailed in Section II.C. of the SOW that requires the completion of additional groundwater studies. Details pertaining to the objectives, approach, means and methods of the AGWS are outlined in this Work Plan or are included in referenced plans developed as part of the RD, and previously approved by U.S. EPA.

1.1 Objectives

The scope of work outlined in this AGWS Work Plan was developed to supplement contaminant nature and extent data obtained from prior remedial investigation (RI) activities. This AGWS Work Plan presents a scope of work to carry out the groundwater investigation activities to be completed during the RD based on the requirements of the SOW. This work will include gathering additional data that will be used to determine if Monitored Natural Attenuation (MNA) is a viable remedy for groundwater at the CRS Site, and to further document the existing MNA mechanisms and degradation pathways as appropriate to support selecting MNA as the chosen remedy for Site groundwater. The work completed in accordance with this Work Plan will be used to define COC nature and extent in Site groundwater. Additional data will be obtained during the investigation to determine if cross-river transport of Site COCs is probable. If it is determined that cross-river COC transport is probable, then additional follow-on investigation will be proposed in the AGWS Report that will be used to determine if such transport has occurred and if the vapor intrusion pathway may be complete at locations on the downgradient (west) side of the river.

Prior to the development of the AGWP Work Plan, the Performing Parties completed groundwater sampling at the Site in September of 2010. The sampling event indicated that four of the five sandstone wells had no detectable volatile organic compounds (VOCs) or very low level detections (below maximum contaminant levels (MCLs)), but that one well, MW-6, contained impacted groundwater and non-aqueous phase liquids (NAPL). Following the identification of NAPL at MW-6, a soil investigation was completed in November of 2010 in the area of MW-6 designed to determine the source of the NAPL material. The results of the groundwater sampling event and soil investigation are summarized in this report. Based on the results of these investigations, the Performing Parties will install borings/wells in the sandstone bedrock, in addition to those required by the SOW, to better define the nature and extent of impact

identified at MW-6. This AGWS Work Plan describes the work required by the SOW and the proposed additional work.

1.2 Report Organization

This AGWS Work Plan supplements the Remedial Design Work Plan (RDWP) that was approved by U.S. EPA in February 2011, and meets various Work Plan content requirements provided in the CD, SOW, and USEPA regulatory guidance through reference to the RDWP, and through descriptions of work relating specifically to the groundwater studies. Information from the RDWP such as the Field Sampling Plan (FSP), Quality Assurance Project Plan (QAPP), and Health and Safety Plan (HASP) is included in CD ROM format (Appendices A, B and C respectively) in this document. This AGWS Work Plan proposes the installation of additional monitoring wells, outlines the methodology for vertical aquifer profiling, summarizes the analytical parameters to be obtained during the study, and outlines specific well construction and drilling methodology that will be used during the AGWS.

1.3 Overall Management Strategy

The overall management strategy for developing and performing the AGWS mirrors the strategy outlined in Section 2 of the RD Work Plan as it is integral to development of the groundwater remedy for the Site. In summary:

1. The Performing Parties are responsible for the preparation of the RD for the Site. The Technical Committee is a subset of the Performing Parties that actively manages the on-site actions of the Performing Parties. The Performing Parties Steering Committee holds the authority to make most decisions regarding the remediation and management of the Site.
2. Patrick Steerman of Steerman Environmental Management and Consulting, LLC is the Project Coordinator for the Performing Parties and provides review of documents, monthly reports to USEPA, and general coordination of activities for the Site for the Performing Parties. Doug McWilliams, Esq. of Squire, Sanders, and Dempsey (US), LLP is the Chairman of the CRS RD/RA Group and common legal counsel for the CRS Performing Parties.
3. Brown and Caldwell Ohio, LLC (Brown and Caldwell) is the Supervising Contractor contracted by the Performing Parties and approved by U.S. EPA to complete the RD for the Site on behalf of the Performing Parties. Within Brown and Caldwell, Ihsan Al-Fayyomi is the Regional Manager responsible for the consulting practice in the Midwest. James Peebles is the Project Manager for the CRS RD, and is directly responsible for managing and coordinating the pre-design activities and all disciplines associated with producing the RD. James Krebs is the Quality Manager for field work completed by Brown and Caldwell associated with the RD.
4. Contractors completing work related to the RD will be subcontracted by Brown and Caldwell for such activities as soil borings, groundwater monitoring well installation, analytical work, surveying, and waste handling. Brown and Caldwell will provide oversight for all subcontractors involved in the completion of the RD.
5. Michelle Kerr has been designated as USEPA's Remedial Project Manager and Thomas C. Nash is USEPA's Associate Regional Counsel for this Site.
6. Larry Antonelli has been designated as Ohio EPA's Project Coordinator for this Site.

1.4 Schedule

This scope of work will be performed in accordance with the Project Schedule presented in the RD Work Plan, included for convenience in this AGWS Work Plan as Figure 1-1. The major milestones of the AGWS are listed below.

- AGWS Work Plan Submitted March 31, 2011
- USEPA AGWS Work Plan Comments April 26, 2011
- Revised AGWS Work Plan Submitted June 3, 2011
- USEPA Approval of AGWS Work Plan June 27, 2011
- Field Work June 28, 2011- August 26, 2011
- Submit Draft AGWS Report October 27, 2011
- Approval of AGWS Report November 28, 2011

Section 2

Background

This section contains a summary of site features, investigative and remedial history. A more comprehensive summary is provided in Section 1 of the RD Work Plan.

2.1 Site Description

The Site is located at 142 Locust Street (formerly Maple Street) in Elyria, Lorain County, Ohio (Figure 2-1) and is located in a predominantly industrial area of Elyria, Ohio. The Site's latitude is 41 degrees, 22' 14.45" N and its longitude is 82 degrees, 06' 14.8" W. The western boundary of the Site runs along the East Branch of the Black River (River). To the north and east, the Site is bordered by the BASF Corporation (formerly Engelhard Corporation, and prior to that the Harshaw Chemical Company). Locust Street runs along the eastern boundary of the CRS Site. The M&M Aluminum Siding property to the south was recently acquired by BASF for an expansion project. Figure 2-2 is a Site layout drawing including on-site features and property.

2.2 Site History

The Site has been in industrial use since the late 1800's. The Site housed a municipal gas plant (MGP) from 1878 to approximately the turn of the century, based on information obtained from Sanborn maps. The maps indicated that the Gas Works was no longer in operation in 1904 and was indicated as not operating in all subsequent Sanborn maps reviewed. A single, circular gas holder was present in the southernmost location noted on Figure 2-2, and the second gas holder (the northernmost) was noted in Sanborn maps beginning in 1893. The Sanborn maps do not show additional industrial activity at the site until 1970, when that map indicates the presence of drums. This would have been after Russell Obitts began a spent solvent processing operation at this location, which was ongoing from 1960 to 1974. On January 1, 1974, Chemical Recovery Systems (CRS) assumed operation of the Site through a stock purchase agreement with the Obitts Chemical Company. From 1974 to 1981, CRS continued solvent reclamation operations and sales. The solvents continued to be stored in 55-gallon drums, ASTs, and tanker trucks, and it is alleged that several spills and releases occurred during this timeframe. In 1980, the USEPA filed a lawsuit against CRS, requiring the facility owners to abate environmental issues identified at the Site. In response to this lawsuit, CRS ceased the receipt, processing, and storage of spent solvents and removed tanks, drums, and other solvent containers from the Site in 1981. CRS ceased operations and filed for bankruptcy prior to 1983.

2.3 Investigative and Remedial History

The Site and the adjacent BASF property have undergone extensive investigative and remedial actions between the dates of 1981 and 2006. The brief summary of these actions is provided in the following bullets.

- USEPA FIT Assessment Results (1981-82): In August 1978 and 1980, the Ohio Environmental Protection Agency (Ohio EPA), Northeast District Office alleged that releases from the Site were impacting the Black River. In August and September 1981, Ohio EPA performed a Hydrogeological and Extent of Contamination Study. The results were reported in April 1982. Four monitoring wells (MW-1 through MW-4) were installed, and soil, groundwater, surface water, and stream sediments

samples were collected. Site soil and groundwater were impacted with volatile organic compounds (VOCs), polychlorinated biphenyl (PCBs), semi-volatile organic compounds (SVOCs) and metals. Sediment and surface water samples also contained concentrations of VOCs, SVOCs, and metals.

- CRS Remedial Activities (1983): A Consent Decree was issued for the Site on 12 July 1983. CRS was instructed to 1) Excavate all visibly impacted soil, 2) Excavate the perimeter of the Brighton Still Building in the northwest corner of the Site, 3) Dispose of all excavated soil, 4) backfill the excavated areas with clean, clay-containing fill, and 5) gently grade the Site towards the River. At the time of the Consent Decree, CRS had ceased the receipt, processing, and storage of spent solvents on Site. Tanks, drums, other spent solvent containers, and distillation units were removed from the property. Buildings, except for the warehouse/office building and a portion of the Rodney Hunt Still Building, were demolished. At this time, CRS also secured the Site with a fence. CRS excavated impacted soil and disposed of the soil in an approved waste disposal site by 15 September 1983. After conducting a site inspection on November 7, 1983, the USEPA concluded that CRS was in compliance with the cleanup stipulated in the Consent Decree.
- Ohio EPA STEP Investigation (1996): In August 1996, Ohio EPA personnel conducted a Site Team Evaluation Prioritization (STEP) Investigation. Soil, groundwater, surface water, and stream sediment samples were collected during this investigation. Only two of the four previously installed monitoring wells (MW-1 and MW-2) could be located at the time of this 1996 investigation. VOCs, PCBs, and SVOCs, were detected in the Site soil samples. Monitoring wells MW-1 and MW-2 contained concentrations of VOCs, SVOCs, and metals. No PCBs were detected in the Site's groundwater. VOCs and metals were detected at concentrations above action levels in surface water samples.
- Health Consultation - Agency for Toxic Substances and Disease Registry (1999): On July 2, 1999, the Agency for Toxic Substances and Disease Registry (ATSDR) with the support of Elyria Health Department completed a Health Consultation, which provided information about the potential health effects associated with the Site. ATSDR concluded that the Site posed no apparent public health hazard to area residents, and potential workers who came in contact with Site soils had minimal health risks. Sediment contamination adjacent to the CRS Site, and elevated concentrations in the surface water at the storm sewer outfall were unlikely to result in adverse health effects. A November 2001 water well search conducted by the Ohio Department of Natural Resources (ODNR) confirmed that there were no drinking water wells within a one-mile radius of the site.
- Previous Investigations and Remedial Activities on Adjacent Property (BASF site): The CRS Site comprises less than 10% of the peninsula that is primarily occupied by the BASF facility. Several environmental investigations have been conducted on this property. Prior to 1992, six subsurface investigations were performed on the BASF property to characterize the soil and groundwater. Soils were found to contain concentrations of metals, and the groundwater had been impacted by metals and VOCs. A Corrective Measures Study (CMS) was performed in March 1997 to identify and evaluate potential remedial alternatives for the releases that have been identified at the BASF site. Asphalt cap and curbing, stormwater drainage enhancements, and institutional controls were the chosen remedies.
- Parsons - Remedial Investigation/Feasibility Study Reports – Chemical Recovery Systems, Inc. Site (Rev 3 August 2006): In response to the May 2002 Administrative Order on Consent (2002 AOC), a remedial investigation was conducted in 2003 with additional investigation conducted in 2005. The results of the remedial investigation were presented in the *Remedial Investigation Report, Chemical Recovery Systems, Inc.* (Parsons, 2006a), and indicated that: 1) soils and groundwater at the CRS Site have been impacted by historic activities; 2) surface water has not been impacted by historic activities; 3) sediments have not been impacted by historic activities, and 4) suggested CRS might not be the source of the elevated arsenic levels. The report also included the results of a Human Health Risk Assessment (HHRA) and a Screening Level Ecological Risk Assessment (SLERA). A feasibility

study (*Feasibility Study, Chemical Recovery Systems, Inc.*, Parsons, 2006b) was also prepared in response to the 2002 AOC and approved by USEPA on September 11, 2006. In addition to “no action”, the alternatives evaluated in the feasibility study included various capping technologies and excavation and disposal. This feasibility study concluded that any of the capping alternatives would meet the evaluation criteria, with the final selection to be dependent on future land use.

2.4 2010 Groundwater Sampling Events

On September 20, 2010, BC provided a letter to USEPA indicating that a groundwater sampling event would be completed at the Site on September 22 and 23, and approval of the sampling event was received by email. The letter indicated that wells MW-5, MW-6, MW-16, L-2 and L-3 would be sampled, and the samples would be analyzed for VOCs. The purpose of this event was to update the groundwater database for the site prior to completion of the RD, allowing a more current assessment of the groundwater conditions. The last groundwater sampling event had been completed in 2003.

The wells were sampled on September 23, 2010, except well MW-6, which was sampled on September 29, 2010. The wells were re-developed prior to sampling to obtain groundwater samples that were relatively low in turbidity and representative of the groundwater at the location of the well. Field parameters, including temperature, pH, conductivity, oxidation reduction potential (ORP), dissolved oxygen (DO), and turbidity were obtained periodically during well development.

Following re-development of the wells and after groundwater levels recovered, groundwater samples were collected using a new disposable bailers and new nylon rope. The same set of field parameters listed above was obtained during the purging process and at the time of sample collection. The samples were handled in accordance with the existing Site FSP and QAPP, and were sent by overnight courier to Test America in North Canton Ohio for analysis of Volatile Organic Compounds (VOCs) by Method SW-846 8260 B. Standard chain of custody procedures described in the existing QAPP were utilized for shipment of the samples to the laboratory.

In general, the analytical results indicated low concentrations of VOCs in all monitoring wells. Monitoring wells MW-5 and MW-16 are two of the three wells completed in the Berea Sandstone on the CRS property. Samples from these wells had detections or estimated (J) values for several compounds at very low levels, which is consistent with data obtained at these wells during the RI (all of the detections were below the respective maximum contaminant levels (MCLs) for the compounds identified). Samples from wells L-2 and L-3, located on the BASF property (across Locust Street from the CRS Site), were non-detect for VOCs except for a low-level chloroform detection at well L-2. In general, the concentrations observed in this sampling event were lower than those obtained during the RI.

During groundwater sampling of monitoring well MW-6, NAPL was detected as a thin floating layer in the well (LNAPL) and as a small pool of DNAPL that formed at the base of the well. Groundwater and NAPL samples were submitted to the laboratory for analysis. Samples MW-6A and MW-6B are water samples that were in contact with NAPL material in the sample vials from the time of collection until the samples were analyzed. Sample MW-6A was in contact with material that was identified as LNAPL, although the material was difficult to obtain in quantity, tended to stick to the sides of the vials, and generally could not be identified as a floating separate-phase material.

Sample MW-6B consisted of groundwater that was in contact with the DNAPL material obtained from MW-6. Analysis was performed on the DNAPL material itself from MW-6. Note that naphthalene can be obtained from either VOC or SVOC scans due to the time at which it elutes from the GC column. Not enough DNAPL or LNAPL material was present in the MW-6 NAPL samples to complete an SVOC analysis. There was an insufficient quantity of the material identified as LNAPL to complete either VOC or SVOC analysis.

Analytical results from this sampling event are summarized in Table 2-1. The complete laboratory data packages and data validation memos are included in Appendix D. Appendix D also contains copies of the field sampling forms completed at the time of the sampling event.

2.5 2010 MW-6 Area Soil Investigation and Groundwater Sampling

Based on the presence of NAPL material at well MW-6, a Geoprobe® investigation was completed in the MW-6 area in November 2010 to better define the source of the material. A plan for the investigation was submitted to USEPA on October 26, 2010. Comments regarding the proposed investigation were received on November 1, 2010 and an email response to the comments was provided on November 5, 2010. A follow-up conference call was held on November 18, 2010 to discuss the comments and responses and USEPA provided approval for going forward with the scope of work for the investigation.

The investigation focused on locations upgradient of well MW-6 and in the vicinity of the two former Rodney Hunt stills where it was speculated that NAPL may have entered the vadose zone soils, ultimately reaching the MW-6 groundwater. The investigation was completed between November 16 and November 18, 2010. The Ohio EPA was on-site for most of the investigation and USEPA was also on-site to observe a portion of the investigation.

The upper surface of the Berea Sandstone in the area of MW-6 is present at a depth of approximately five to eight feet below ground surface (bgs). The investigation focused on the identification of impacted soils indicative of the presence of NAPL. Information obtained during the RI/FS investigation suggested that the Berea Sandstone is overlain by vadose zone soils that are generally of higher permeability than the sandstone. The presence of permeable soil above the sandstone could have resulted in lateral migration of NAPL on top of the sandstone. Therefore the investigation was also used to better define the upper surface of the Berea Sandstone in the area of the former stills, and probable drainage directions for water or NAPL that contacts the bedrock surface.

The investigation used a Geoprobe® drilling rig to complete the following tasks: (1) collect cores of soil to better define the soil types present in the vadose zone in this area, (2) obtain samples for laboratory analysis in locations where heavily impacted soils were encountered, (3) identify the top of the sandstone at various locations in this area to provide a more detailed top of bedrock contour map, and (4) install vapor probes at the bedrock interface that could be used to better define the area where the bedrock may be impacted with NAPL if direct soil sampling data did not identify a NAPL zone.

The investigation consisted of a grid of borings placed approximately 10 feet on center from the MW-6 area east through the area of the former Rodney Hunt Stills. A total of 40 borings were advanced using Geoprobe® dual-tube tooling to allow the collection of nearly continuous soil samples in each boring location. All samples were retrieved from the rods in acetate liners, which were opened by the driller for inspection by the field geologist. The cores were screened with a photoionization detector (PID) immediately after opening to identify locations where impacted soil may have been present. The geologist logged the material in the cores from the ground surface to the bedrock interface. Soil samples were collected based on visual and field screening evidence of NAPL or other impact for potential laboratory analysis. The Geoprobe® tooling was advanced to the point of refusal, and determinations were made by the geologist regarding whether the refusal was a result of encountering bedrock or encountering other items such as bricks or other fill material. The floor of the existing Rodney Hunt Still building was cored prior to placement of the four borings located there. Figure 2-3 provides the locations where the 40 Geoprobe® borings were installed. Boring logs for this investigation are presented in Appendix E.

A representative aliquot of each core sample interval was placed in a sealed bag for PID headspace analysis. Soil samples were submitted for analysis based on headspace readings and visual evidence of NAPL or other impact. Samples were submitted from eight Geoprobe® sample locations, and analyzed for volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs) and PCBs in accordance with the Quality Assurance Project Plan (QAPP).

The vadose zone materials consisted primarily of fill, including red bricks, sand, cinders, silty clay, and sandstone fragments. The fill was generally dry to moist over most of the study area, with the exception of the bedrock depression, where wet soils were encountered from approximately 8 to 10 feet below grade.

During the Geoprobe investigation, additional groundwater samples and a DNAPL sample from MW-6 were collected and submitted for analysis. A swab sample was collected from material clinging to sides of the glass sample container that included water and DNAPL from MW-6. It is not certain if this highly hydrophobic material should be classified as an LNAPL or a DNAPL, but it was listed as an LNAPL for the purpose of analysis. Insufficient DNAPL was present in MW-6 to allow analysis of VOCs and SVOCs, so only SVOCs were analyzed from this sample to supplement the VOC analyses that had been completed in the September sampling event. The DNAPL was found to contain 15 SVOC compounds, with naphthalene having the highest concentration at 3400 mg/kg. Most of these SVOCs were also detected in the soil samples from GP-74 and GP-84, which contained NAPL. The LNAPL sample was analyzed for VOCs, and was found to contain chlorinated compounds, benzene, toluene, ethylbenzene, and xylene (BTEX) compounds and naphthalene.

A dark reddish brown NAPL with a sharp odor was found in borings GP-74 and GP-84 (Figure 2-3). The NAPL was encountered near the bottom of the borings, at about 16 feet below grade. The soils in these two borings were composed primarily of silty clay. The other borings in the bedrock encountered primarily fill materials such as bricks, sand, sandstone fragments, and cinders. Wet soils were present in the depression borings at approximately 8 to 10 feet below grade. Samples from the NAPL-impacted soils were submitted for analysis. The results indicated the presence of chlorinated compounds and other volatiles, BTEX, and several SVOCs, with naphthalene being the predominant compound of both the VOC and SVOC analyses. The presence of naphthalene, and other SVOCs, suggests that the source of the NAPL may be related to historical MGP operations.

The MW-6 groundwater samples were submitted for SVOC and cyanide analysis. Four SVOCs were detected, with naphthalene at the highest concentration (6000 µg/L). Cyanide was detected at 0.038 mg/L.

The soil sampling results are summarized in Table 2-2 and shown on Figure 2-4. The laboratory analytical packages for the soil samples are included in Appendix D along with a data validation memo.

The soil sample results indicated the presence of VOCs and SVOCs in all samples (Figure 2-4). The sample with the highest VOC impact came from GP-57 at a depth of 4 to 8 feet, in wet soils above bedrock. Prominent VOC detections in this sample were toluene (1600 mg/kg), total xylenes (1300 mg/kg) and ethylbenzene (300 mg/kg). This sample also had the highest levels of chlorinated VOCs, with the highest being 1,1,1-TCA at 160 mg/kg. Concentrations of VOCs were generally higher in this sample than in the soil samples containing NAPL taken from GP-74 and GP-84. Elevated SVOC concentrations, comparable with those found in the NAPL soil samples, were detected in the GP-47 sample from 4 to 8 feet. Phenanthrene was the predominant SVOC detected at this location at a concentration of 120 mg/kg.

PCBs were detected in samples from borings GP-54, GP-57, GP-75, and GP-80 at a maximum concentration of 0.41 mg/kg of Aroclor 1254 in the GP-57 sample. The NAPL-impacted samples from GP-74 and GP-84 were non-detect for PCBs.

The November 2010 borings were used to better define the bedrock surface in the MW-6 area (Figure 2-5). East of MW-6 the surface slopes westward in conformance with the general site bedrock surface. A depression in the bedrock is present west of MW-6, extending from the west edge of the Rodney Hunt Still Building northwestward and appearing to join the bedrock depression defined in the RI in the vicinity of borings GP-15 and GP-16. Several of the November borings were completed in this depression, which was found to contain mostly fill materials, with primarily silty clay encountered at borings GP-74 and GP-84. The depression is now mapped as an extension of the bedrock low described in the RI, as shown in Figure 2-5.

The bedrock depression generally corresponds to the locations of the two gas holders that were identified from the Sanborn Maps developed at the time that the site was used as an MGP. The gas holder locations are shown in general form on Figures 2-2 through 2-5 as transcribed from the Sanborn maps. Most of the compounds identified in the soil samples correspond to compounds that would typically be associated with an MGP Site, including the NAPL material identified in borings GP-74 and GP-84.

Section 3

Additional Groundwater Studies

This AGWS Work Plan was prepared to describe the means and methods proposed to obtain additional information about Site groundwater, NAPL, and the bedrock environment. The SOW requires additional groundwater studies be completed due to the high concentrations of constituents of concern (COCs) identified in groundwater at the MW-6 monitoring location, and the lack of downgradient nature and extent definition in the bedrock aquifer system. This section provides information regarding the number and locations of monitoring wells, the methodology for vertical aquifer profiling in the MW-6 area, well construction considerations, drilling methodology, and bedrock evaluation.

This work plan describes the installation of the SOW required monitoring wells and additional borings/monitoring wells that will be installed that are not required by the SOW. An alternate method to vertically profile sandstone in the vicinity of monitoring well MW-6 (and other locations where NAPL material may be encountered) will be used to avoid potential NAPL cross contamination within the bedrock. Additional site evaluation activities to assess the bedrock environment and refine the conceptual Site model are presented. This Work Plan proposes additional data collection to evaluate the potential for cross-river transport of Site COCs, and to provide recommendations for additional work on the downgradient (west) side of the river if the study determines that cross-river transport is probable. Data will also be collected and evaluated to further support a determination regarding the viability of MNA as the chosen remedy for Site groundwater.

3.1 Site Preparation

Prior to initiating the investigative activities outlined in this AGWS Work plan, BC will perform the following site preparations.

- Subcontract with an Ohio licensed driller, surveyor, and analytical laboratory.
- Notify U.S. EPA of schedule for mobilizing to the site and performing the investigative work.
- Notify BASF of schedule for performing the work and provide documents and notifications required by the access agreement.
- Identify and mark equipment laydown areas, decontamination areas, and IDW staging area.
- Identify and mark traffic flow patterns.
- Mark all proposed drilling locations.
- Identify and isolate all above ground electric utilities within 20 feet of proposed drilling locations (none are expected for this mobilization).

3.2 Vertical Profiling and Well Installation

The vertical profiling of the sandstone at MW-6 required by the SOW will be substituted with a method that is less prone to causing NAPL cross contamination during drilling and less likely to leave a pathway for NAPL migration to lower elevations within the bedrock. Evidence obtained to date suggests that the primary bedding planes (and likely zones for NAPL and groundwater transport) may be nearly horizontal, and it is possible that NAPL identified at MW-6 is confined to the upper part of the sandstone bedrock.

Vertical profiling at MW-6 will be conducted by installing multiple (likely three) borings/wells at a location approximately 20 feet west of MW-6 (Figure 3-1). The first boring will be installed by drilling through the

surface soil and into the bedrock surface using air rotary methods until reaching competent bedrock. A five-inch steel casing will be set in the upper portion of the sandstone bedrock and grouted in place. After the cement-bentonite grout has set for at least 24 hours, the boring will be advanced inside the steel casing using a 94 millimeter core barrel. Core will be obtained in five foot intervals and brought to the surface for inspection by the geologist. The geologist will log the borings for features such as fractures and will screen all sections of the core with a PID to identify zones where NAPL impact may be present. When NAPL evidence is identified, the boring will be suspended at that depth. The drill rig will then offset from this location and begin a second boring. The second boring will be drilled below to the approximate depth that NAPL was suspected and where competent (non-fractured) bedrock was logged below the NAPL. A five-inch steel casing will be set in the rock at this elevation and grouted in place. The cement-bentonite grout will be allowed to set for at least 24 hours and the boring will be advanced inside the steel casing as described above. This process will be repeated until a boring reaches the sandstone shale interface, where that boring will be terminated. It is expected that this process will require approximately three offsets to reach the shale interface, although more or fewer offsets will be used depending on the identification of NAPL in core from the borings.

Each boring termination point will be completed as an open rock well. Three of the six sandstone wells sampled in September 2010 were open rock wells (L-2, L-3, and MW-16). These wells tended to produce clear water with less need for development than the wells completed with PVC (MW-5 and MW-6). There are several advantages to completing the new sandstone wells as open rock wells, including: (1) the wells can be more easily developed to produce sediment-free groundwater, (2) geophysical tests can be completed as needed on the well, (3) if NAPL enters the well after the well has been completed (due to migration), the specific fracture area where NAPL is entering the well can be identified, and lower fractured zones of the exposed bedrock can be sealed off (if needed), (4) there is no potential for NAPL to damage the well screen or casing material (as can happen with PVC), and (5) there is no possibility for NAPL to enter the cored hole without being detected in the well (this can happen with a sand-packed well and can allow DNAPL to move to a lower fracture zone without being positively identified in the well).

The EPA well designated as “A” in the SOW will be located approximately 70 feet west of the wells installed to complete vertical profiling near MW-6 in the sandstone bedrock (Figure 3-1). The boring(s)/well(s) at this location will be installed in the same manner as the wells described above for the MW-6 area, if NAPL is encountered in the core. If NAPL is not encountered at this location, the boring may be advanced as a single boring/well as specified in the SOW.

Two additional sets of nested wells near the MW-7D location and approximately 40 feet south and east of MW-7 (see Figure 3-1) are proposed in addition to the wells designated for installation by the SOW. The wells will be installed in the same manner as described above for the MW-6 area well group if NAPL is encountered during the boring process. As with the well group proposed for the MW-6 area, the borings may be completed as a single boring, if there is no sign of NAPL as the boring is being advanced. The well noted on Figure 3-1 as MW-X will be installed in the same manner as MW-7 and will include a well group if NAPL is encountered or suspected during completion of the boring.

EPA wells designated as “B, C, D, E and “F” will be installed as indicated in the SOW except that a five-inch steel casing will be set into the top of the sandstone bedrock for those wells designated for placement in the sandstone and the casing will be grouted in place. The borings for each sandstone well will then be advanced using a 94 mm core barrel to the sandstone shale interface. It is not expected that NAPL will be encountered at any of these well locations, but the core will be inspected and if NAPL is encountered, the procedures outlined for MW-6 well cluster will be utilized to obtain core from the entire depth of sandstone, while preventing cross contamination. The wells placed in the sandstone will be completed as open rock wells as described above. Wells completed in the Bedford Shale, beneath the sandstone, will be installed with a PVC screen, casing and sandpack as described below and in the FSP.

For wells to be installed in the shale bedrock (wells D and F), air rotary drilling will advance into the shale to the point that competent rock is encountered, and a five-inch casing will be set in the shale and grouted in place. The cement-bentonite grout will be allowed to set for at least 24 hours and the 94 mm core barrel will be advanced by wireline to a depth of ten feet into the Bedford Shale. Core will be retrieved from the boring and logged by the BC geologist. A two-inch polyvinyl chloride (PVC) well will then be installed in the boring with a five foot PVC screen placed at the base of the boring. Sand will be installed around the screened interval to two feet above the top of the screen. Bentonite pellets will be placed above the sand to a depth two feet above the base of the steel casing. The pellets will be hydrated as needed and allowed to set for an appropriate period of time before grouting the PVC well casing to the ground surface.

All wells installed for this investigation will be named at the time of placement according to the following convention. The wells will be named as MW-X, where the “X” is replaced with the next number in sequence following MW-9 (the last well number completed during the RI. If more than one well is completed at a given location (a well group) the wells will retain the same number and the number will be followed by a letter starting with “A” for the well closest to the ground surface and proceeding through the alphabet. If a well cluster is placed at the location of an existing well (such as MW-7D), the same convention will be used with well closest to the ground surface being named MW-7A (in this case).

Well installation records for each well installed in this investigation will be completed by the driller, reviewed by the BC geologist and submitted to the Ohio Department of Natural Resources. To minimize the chances of cross-contamination, well installation will begin with SOW well locations B, C, D, E and F, which are located in areas where DNAPL is not expected to be present. The well at SOW location A will be completed next, followed by well locations MW-7, MW-“X” (see Figure 3-1) and the MW-6 cluster will be completed last.

All wells will be provided with surface completions consisting of the five-inch casing installed during the drilling operation fitted with a lockable top and a concrete pad surrounding the well. For the shale wells, the annulus between the five-inch steel casing and the PVC riser will be filled with bentonite grout, and a weephole will be drilled near the top of the concrete pad. The steel casing will be labeled with vinyl adhesive lettering or other suitable label indicating the well number. Decontamination of drilling equipment will be completed after use for all components in contact with the soil/bedrock and groundwater. Decontamination procedures are provided in detail in the FSP. Investigation derived waste (soil, rock, groundwater, personal protective equipment (PPE), and decontamination water) generated during the investigation will be containerized and properly labeled according to the procedures defined in the FSP.

The wells will be surveyed by an Ohio Licensed Professional Surveyor. All monitoring points will be located and elevations measured to the nearest one-hundredth of a foot (0.01 foot) using North American Datum (NAD) 83, and North American Vertical Datum (NAVD) 88 respectively. Surveying data will be provided in ASCII format in both longitudinal/latitudinal and State Plane Coordinate Systems.

3.3 Bedrock Evaluation

3.3.1 Rock Coring and Geophysics

Borehole geophysical testing will be performed at selected locations where cores are taken from the Berea Sandstone and the Bedford Shale. Geophysical testing can provide information in addition to that provided by the core regarding the number, orientation, and relative hydraulic conductivity of fracture zones and bedding planes in the sandstone.

The proposed geophysical testing will include one or all of the following techniques for a given boring: acoustic televiewing, gamma logging, caliper, and heat pulse flow logging. These four geophysical

methods will help to define structural features such as fractures and bedding planes that may control flow of groundwater and NAPL in Site bedrock. The use of a specific geophysical method on a given boring will be decided by the BC geologist in the field based on the nature of the core obtained from the boring, observed success of the method at the Site, and the need to further define some or all of a boring with geophysical methods. The geophysical methods that may be used are described below.

An acoustic televiewer uses sound waves to create a high-definition image of the borehole wall. The image shows texture of the rock, fractures and other features that would not necessarily be visible in a normal downhole camera picture. Non-horizontal fractures present as sine waves, and the strike and dip of each fracture is calculated and presented with the log in the geophysics report. The orientation of fractures and bedding plans will facilitate an understanding of the potential for NAPL and groundwater to move within the Site bedrock.

Gamma ray logging is a method of measuring naturally occurring gamma radiation to characterize the rock or sediment in a borehole. Different types of rock emit different amounts and different spectra of natural gamma radiation. In particular, shales usually emit more gamma rays than other sedimentary rocks, such as sandstone, gypsum, salt, coal, dolomite, or limestone. Gamma logging will help to define shale layers that may be present in the Site sandstone. These layers may alter flow patterns in the sandstone bedrock.

The caliper tool measures the variation in bore hole diameter as it is withdrawn from the bottom of the hole. It is constructed with two or more articulated arms that push against the bore hole wall to take measurements. The arms show variable movements of the cursor by measuring electrical resistance, creating electrical variation. The variation in output is translated into changes of borehole diameter. The caliper log is printed as a continuous series of values of hole diameter with depth. The caliper log helps to identify fractures, and is presented in conjunction with other logs in the geophysics.

The heat-pulse flowmeter is used to measure low flow rates which may lie below threshold limits of conventional impeller tools. The probe contains a horizontal wire-grid heating element and thermistors located above and below it. Apertures in the tool permit the free flow of well fluid through the assembly. Pulses of electric current are applied to the heating grid under surface command, warming fluid in the vicinity of the grid. The warm fluid front migrates towards the thermistors where it is detected. Depending on the direction of flow, either upper or lower thermistor detects the warm fluid front first. The time taken to reach the detector gives an indication of flow rate. The resultant log provides information on the presence of groundwater flow into or from fractures, and thus helps identify preferential pathways in bedrock.

3.3.2 Additional Bedrock Assessment

To better understand the occurrence and flow of groundwater in the sandstone aquifer and potential flow paths, it will be necessary to evaluate characteristics of the Berea Sandstone, which underlies the site. The following assessment will be completed prior to or during the mobilization for drilling the site and/or at the time of the drilling mobilization:

1. A lineament analysis of historic topographic maps and aerial photographs will be completed. Such an analysis will be useful for identifying/confirming vertical or high angle fracturing in the rock and the spacing of these fractures on a regional basis. This will help to define the wider-scale fracturing system in the Berea Sandstone of this area.
2. Evaluation of sandstone outcrops along the river bank at the CRS site, around the peninsula on which the site is located, and directly across the river bank from the CRS site to better define the fracturing patterns present in the sandstone that may provide secondary porosity in the bedrock.
3. Complete additional Geoprobe® borings in the unconsolidated soils to the west of the Geoprobe® study area from the fall of 2010. These borings will be used to identify the bedrock surface in this

area and better define the western and southern edge of the low spot in the bedrock. It is not known how many borings will be needed to define the edges of the bedrock low area, and the locations will be determined in the field as additional depth information is obtained. The first borings will be placed west of GP-82 and GP-84, maintaining the existing grid system. Additional Geoprobe® boring locations may be completed based on the results of these initial borings.

4. Conduct groundwater sampling of the newly installed wells at the same time that the sampling is completed for the wells called for in the SOW. The analytical results from new wells that are not impacted with NAPL will be used to better determine the distribution of chlorinated solvents in groundwater and their relative position to the MGP impacts observed to date.

3.3.3 Bedrock Assessment at the Black River

The potential for cross-river transport of Site COCs will be assessed as a part of the AGWS Work Plan. There are several factors that make cross river transport unlikely including, but not limited to, the following:

1. The sandstone thins at the edge of the CRS site near the eastern river edge and might not be present across the river bottom;
2. If the sandstone is not continuous across the river base, the shale has a far lower potential to transmit groundwater and has not been shown to date to be significantly impacted with Site COCs; and
3. Rivers and streams generally provide a barrier for groundwater transport if the river bed is in contact with (or is a part of) the aquifer. In this case the river will typically be a strong source or sink for the groundwater system and will stop cross-river transport by allowing groundwater to flow to the river (in the case of a gaining stream) or by adding groundwater to the aquifer (in the case of a losing stream).

Data will be collected during the AGWS to: (1) further evaluate if the sandstone aquifer is continuous across the river, (2) confirm that the shale bedrock is not significantly impacted at the CRS Site, (3) evaluate the potentiometric surface of the aquifer in comparison to the river water level to determine if the river is a gaining or losing stream and to evaluate the ability of the river to act as a source or sink for groundwater, and (4) provide additional information regarding the concentration and extents of COCs in groundwater.

The depth of the river will be mapped between the CRS site (east bank) and the bank on the west side of the Black River. River base elevations will be compared to the sandstone-shale interface determined from on-site borings to interpolate an approximate interface elevation at the eastern bank and across the river, and further assess the potential for the sandstone to be continuous across the river. The long term average depth of the Black River at this location will be established based on historic gauge station records. This level will be compared to the potentiometric surface of the sandstone aquifer on the CRS Site to determine if the river is a gaining or losing stream and if it represents a strong or weak sink for the aquifer.

3.4 Groundwater Sampling

All wells installed as a part of the AGWS will be developed according to the procedures detailed in the FSP. Groundwater from each well will be sampled according to the procedures detailed in the FSP and will be analyzed for VOCs and SVOCs according to the methods detailed in the QAPP. Sampling equipment will generally be dedicated to a given well, but non-dedicated equipment will be decontaminated prior to re-use as described in the FSP.

Purge water generated from groundwater sampling will be containerized and labeled in accordance with the procedures defined in the FSP and will be disposed of based on the analytical results of the investigation or results obtained from sampling of individual containers.

Laboratory analytical data obtained from groundwater sampling will be used to further evaluate the nature and extent of Site COCs, and the viability of MNA as a site wide groundwater remedy.

Section 4

Additional Groundwater Studies Report

The following information will be provided in the Additional Groundwater Studies Report following completion of field investigation activities and data analysis.

- Summary of investigative means and methods
- Deviations from the scope outlined in this AGWS Work Plan
- Photographic summary
- Field notes
- Tabulated field and analytical data
- Boring logs and well construction diagrams
- Geophysical raw data and interpretation
- Survey data
- Potentiometric Surface Maps for the shale and sandstone bedrock zones
- Geologic Cross Sections including sandstone and shale interface elevations in relation to the Black River bed to assess the potential for cross-river transport
- Aquifer potentiometric and river water level evaluations to assess the potential for cross-river transport
- Definition of groundwater impact extents in both the sandstone and shale bedrock water-bearing zones
- Assessment of MNA as a site wide remedy for groundwater impacted with Site COCs
- Development of plans for additional work, including further groundwater investigation and soil vapor evaluation on the west side of the river, if cross-river transport of Site COCs is probable
- Data interpretation and conclusions

The AGWS Report will be submitted according to the schedule provided in Section 1.4.

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Figures

- Figure 1-1 Project Schedule
- Figure 2-1 Site Location
- Figure 2-2 Site Layout
- Figure 2-3 Existing Site Sampling Locations
- Figure 2-4 Soil Sampling Results
- Figure 2-5 Bedrock Surface Map
- Figure 3-1 Proposed Well Locations

Figure 1-1
Project Schedule - Remedial Design/Remedial Action
Chemical Recovery Systems Superfund Site - Elyria, Ohio

ID	Task Name	% Complete	Duration	Start	Finish	Qtr 1, 2011			Qtr 2, 2011			Qtr 3, 2011			Qtr 4, 2011			Qtr 1, 2012		
						Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
1	Consent Decree (CD) Lodged	100%	0 days	Wed 4/28/10	Wed 4/28/10															
2	CD Entered by Court	100%	0 days	Thu 7/22/10	Thu 7/22/10															
3	Supervising Contractor Selection	100%	37 days	Wed 6/2/10	Thu 7/22/10															
7	Institutional Control Work Plan	100%	47 days	Wed 6/2/10	Thu 8/5/10															
12	Implement IC Work Plan	100%	54 days	Thu 8/5/10	Wed 10/20/10															
18	Remedial Design Work Plan and Associated Plans	100%	158 days	Thu 7/22/10	Mon 2/28/11	█														
28	Additional Groundwater Studies	12%	195 days	Tue 3/1/11	Mon 11/28/11	█			█											
29	Prepare Draft GW Studies Work Plan	100%	23 days	Tue 3/1/11	Thu 3/31/11	█														
30	Meeting - Additional Groundwater Studies	0%	1 day	Tue 3/15/11	Tue 3/15/11															
31	Submit to USEPA	0%	0 days	Thu 3/31/11	Thu 3/31/11															
32	USEPA Review of Draft GSWP	0%	17 days	Mon 4/4/11	Tue 4/26/11															
33	Revise GSWP per USEPA Comments	0%	22 days	Wed 4/27/11	Thu 5/26/11															
34	USEPA Review and Approval	0%	22 days	Fri 5/27/11	Mon 6/27/11															
35	Field Work	0%	44 days	Tue 6/28/11	Fri 8/26/11															
36	Prepare Draft Additional GW Studies Report	0%	44 days	Mon 8/29/11	Thu 10/27/11															
37	Submit Draft GSR to USEPA	0%	0 days	Thu 10/27/11	Thu 10/27/11	Due 90 days after Field Work is complete														
38	USEPA Review of GSR	0%	22 days	Fri 10/28/11	Mon 11/28/11															
39	GSR Approved	0%	0 days	Mon 11/28/11	Mon 11/28/11															
40	Remedial Design	0%	272 days	Tue 3/1/11	Wed 3/14/12	█														

Project: 139452 - CRS Superfund Site
Date: Fri 3/25/11

Task



Milestone



External Tasks



Split



Summary



External Milestone



Progress



Project Summary

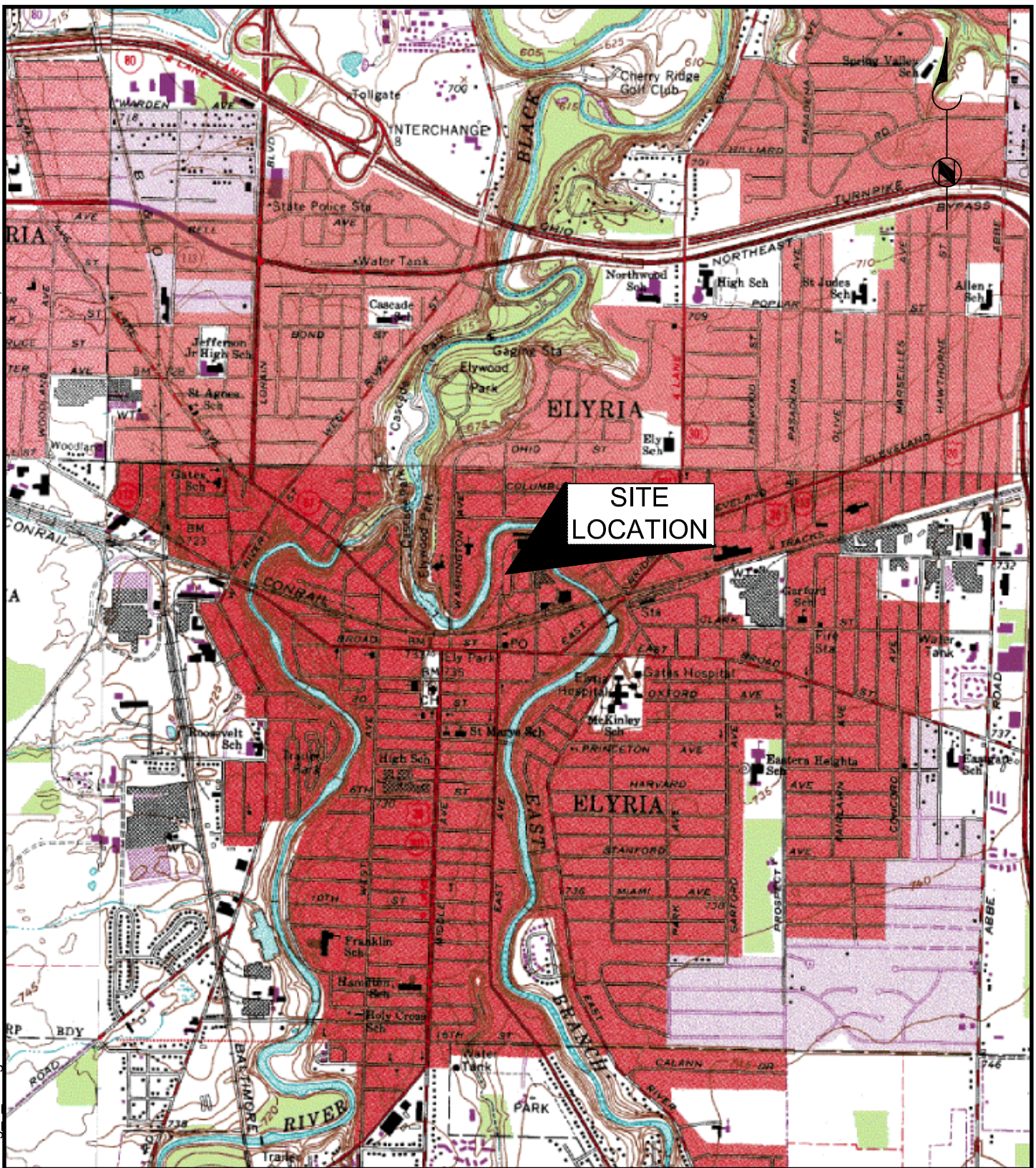


Deadline



Mar 25, 2011 - 11:58am nelmasian

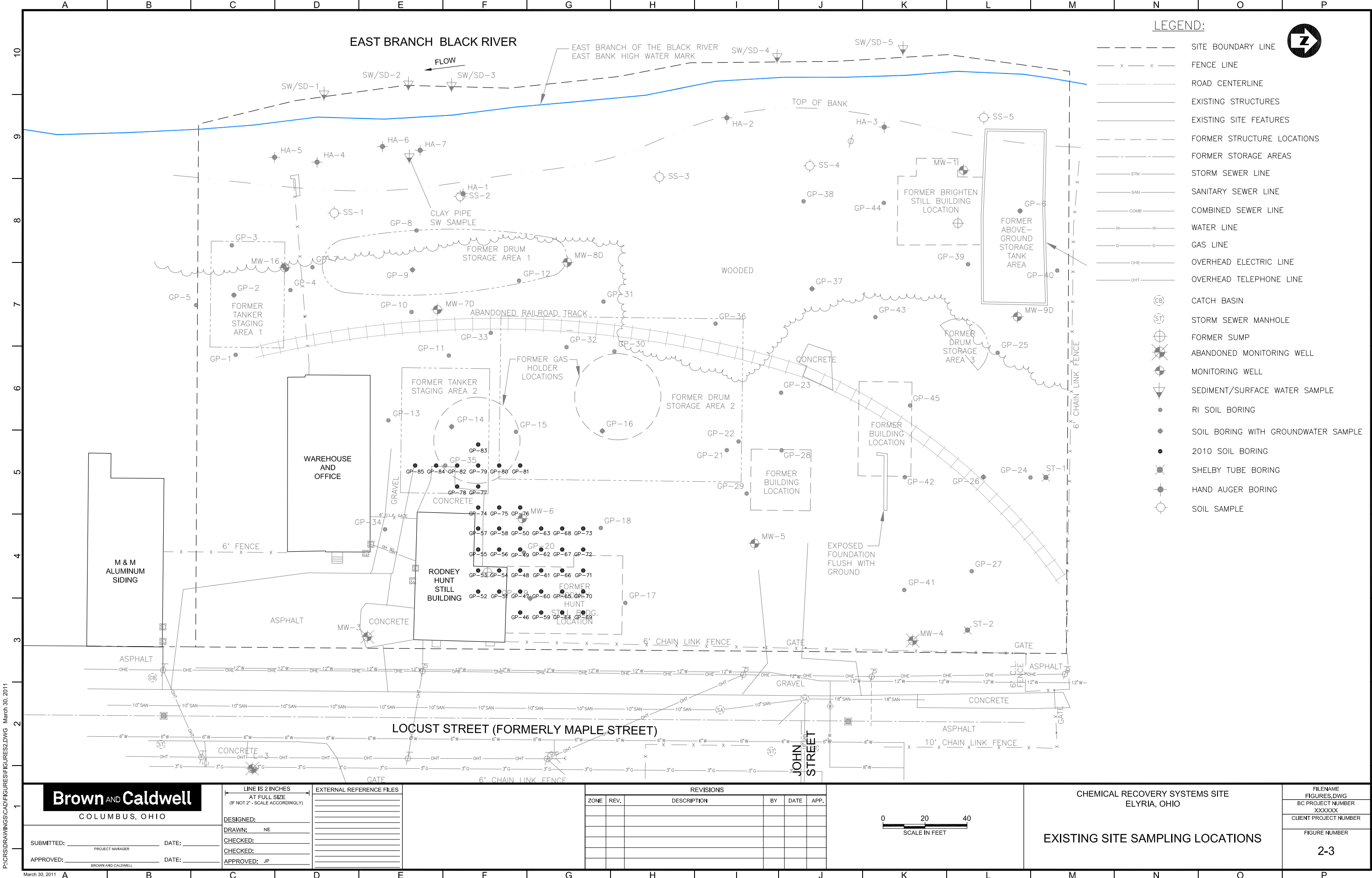
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CHEMICAL RECOVERY SYSTEMS, INC. SITE
ELYRIA OHIO

SOURCE: BASE MAP USGS 7.5 MIN. QUAD., AVON, OH, 1994





P:\CRS\DRAWINGS\CAD\FIGURES\FIGURES2.DWG March 30, 2011

Brown and Caldwell
COLUMBUS, OHIO

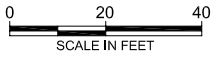
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APPROVED: _____ DATE: _____
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LINE IS 2 INCHES
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(IF NOT 2" = SCALE ACCORDINGLY)

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APPROVED: JP

EXTERNAL REFERENCE FILES	

REVISIONS					
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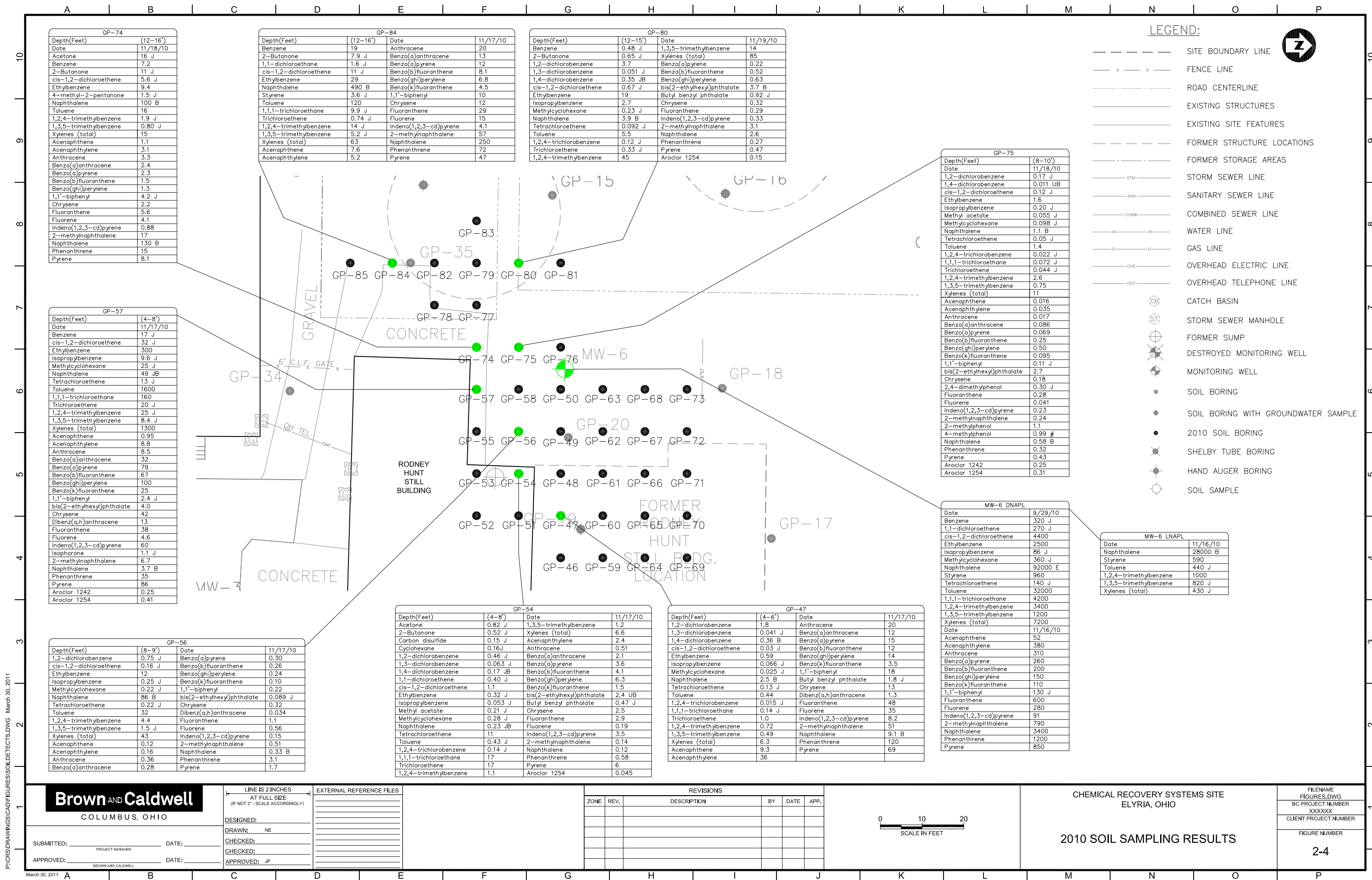


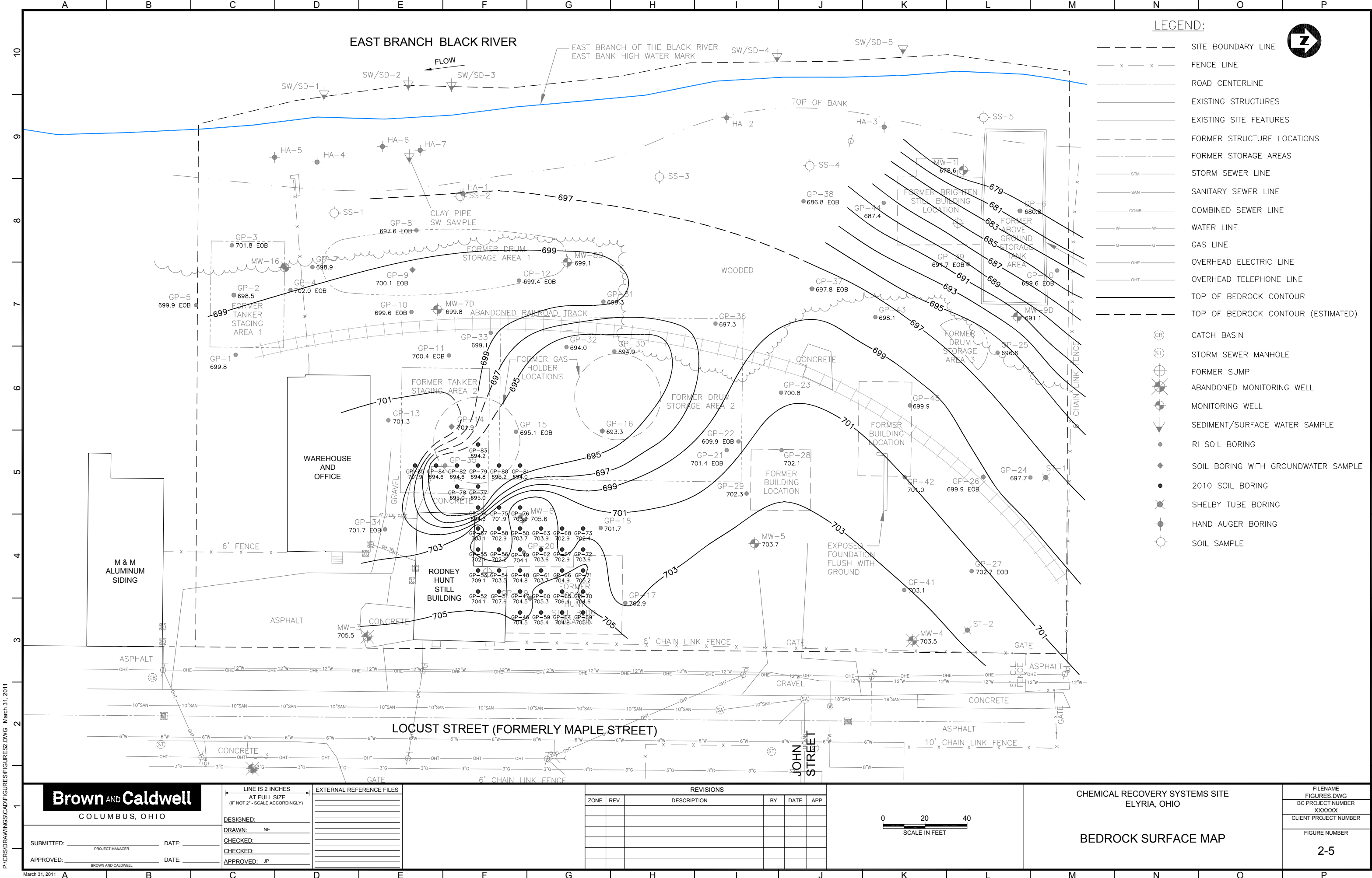
CHEMICAL RECOVERY SYSTEMS SITE
ELYRIA, OHIO

EXISTING SITE SAMPLING LOCATIONS

FILENAME
FIGURES.DWG
BC PROJECT NUMBER
XXXXXX
CLIENT PROJECT NUMBER

FIGURE NUMBER
2-3





LEGEND:

- SITE BOUNDARY LINE
- FENCE LINE
- ROAD CENTERLINE
- EXISTING STRUCTURES
- EXISTING SITE FEATURES
- FORMER STRUCTURE LOCATIONS
- FORMER STORAGE AREAS
- STM
- SAN
- COMB
- W
- G
- OHE
- OHT
- TOP OF BEDROCK CONTOUR
- TOP OF BEDROCK CONTOUR (ESTIMATED)
- CATCH BASIN
- STORM SEWER MANHOLE
- FORMER SUMP
- ABANDONED MONITORING WELL
- MONITORING WELL
- SEDIMENT/SURFACE WATER SAMPLE
- RI SOIL BORING
- SOIL BORING WITH GROUNDWATER SAMPLE
- 2010 SOIL BORING
- SHELBY TUBE BORING
- HAND AUGER BORING
- SOIL SAMPLE

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(IF NOT 2" - SCALE ACCORDINGLY)

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EXTERNAL REFERENCE FILES	

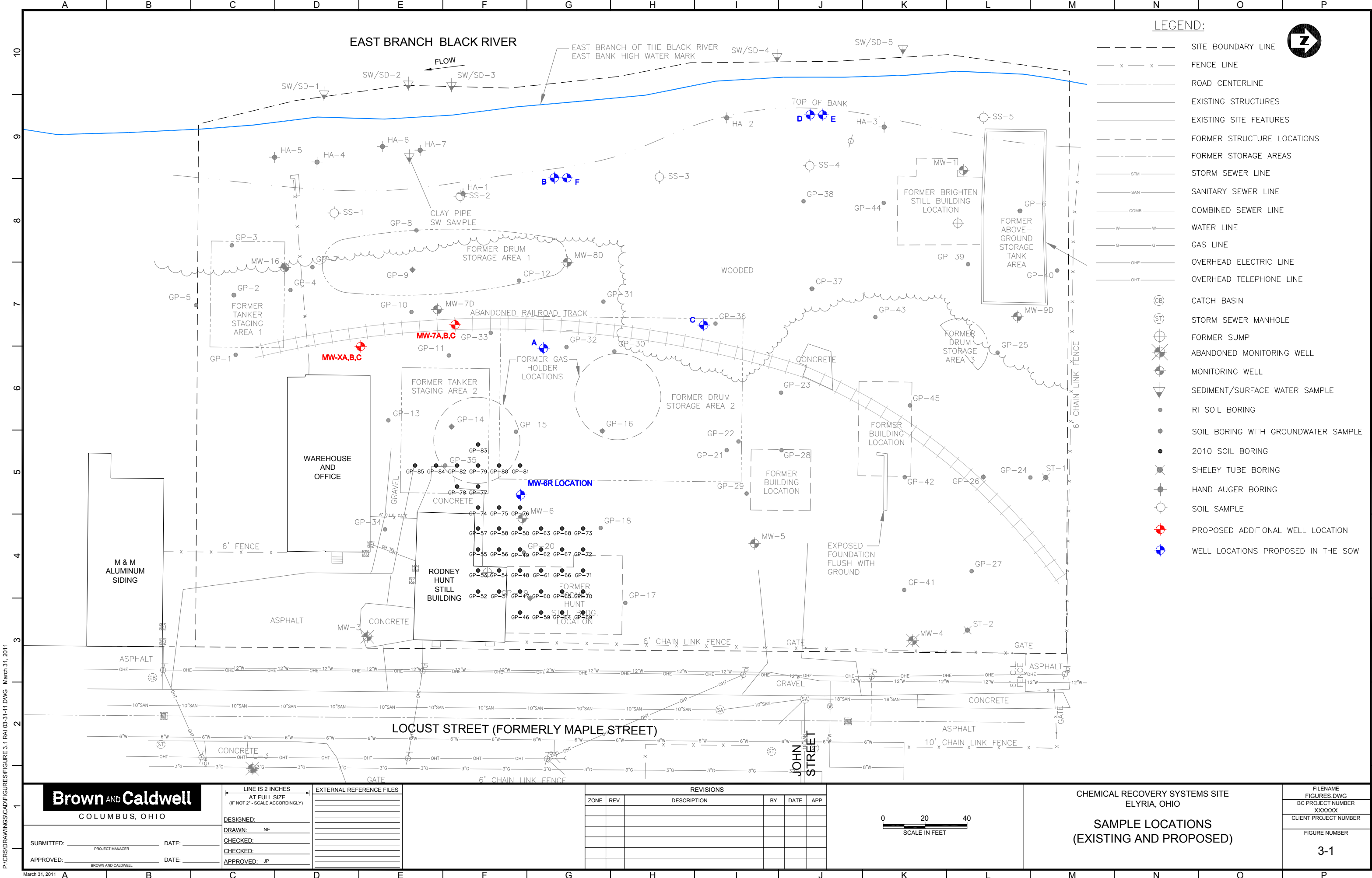
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ZONE	REV.	DESCRIPTION	BY	DATE



CHEMICAL RECOVERY SYSTEMS SITE
ELYRIA, OHIO

BEDROCK SURFACE MAP

FILENAME
FIGURES.DWG
BC PROJECT NUMBER
XXXXXX
CLIENT PROJECT NUMBER
FIGURE NUMBER
2-5



P:\CRSDRAWINGS\CAD\FIGURES\FIGURE 3.1 RAI 03-31-11.DWG March 31, 2011

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LINE IS 2 INCHES
AT FULL SIZE
(IF NOT 2" - SCALE ACCORDINGLY)

DESIGNED: _____
DRAWN: NE
CHECKED: _____
CHECKED: _____
APPROVED: JP

EXTERNAL REFERENCE FILES	

REVISIONS					
ZONE	REV.	DESCRIPTION	BY	DATE	APP.



CHEMICAL RECOVERY SYSTEMS SITE
ELYRIA, OHIO

**SAMPLE LOCATIONS
(EXISTING AND PROPOSED)**

FILENAME
FIGURES.DWG
BC PROJECT NUMBER
XXXXXX
CLIENT PROJECT NUMBER
FIGURE NUMBER
3-1

Tables

Table 2-1 2010 Groundwater Analytical Results

Table 2-2 2010 Soil and NAPL Analytical Results

Table 2-1: CRS Site Elyria - Groundwater and NAPL Sampling Results Summary

Parameter	Units	L-2	L-3	MW-5	MW-5 (duplicate)	MW-16	MW-6A (Groundwater)	MW-6B (Groundwater)	MW-6 (Groundwater)
		9/23/2010	9/23/2010	9/23/2010	9/23/2010	9/23/2010	9/29/2010	9/29/2010	11/19/2010
General Chemistry									
Cyanide, Total	mg/L	NA	NA	NA	NA	NA	NA	NA	0.038
Volatile Organic Compound									
Acetone	ug/L	< 10	< 10	< 1.9 UJ	< 1.1 UJ	< 1.4 UJ	< 17000	< 33000	NA
Benzene	ug/L	< 1	< 1	< 1	< 1	< 1	1400 J	3400	NA
Carbon tetrachloride	ug/L	< 1	< 1	< 1	< 1	< 1	980 J	< 3300	NA
Chloroform	ug/L	9.4	< 1	0.36 J	0.35 J	< 1	< 1700	< 3300	NA
1,1-Dichloroethane	ug/L	< 1	< 1	4.4	4.4	0.29 J	790 J	1300 J	NA
1,2-Dichloroethane	ug/L	< 1	< 1	< 1	< 1	< 1	600 J	< 3300	NA
cis-1,2-Dichloroethene	ug/L	< 1	< 1	2.2	2.1	0.42 J	59000	110000	NA
trans-1,2-Dichloroethene	ug/L	< 1	< 1	0.24 J	0.24 J	< 1	< 1700	< 3300	NA
1,1-Dichloroethene	ug/L	< 1	< 1	< 1	< 1	< 1	1100 J	2900 J	NA
trans-1,3-Dichloropropene	ug/L	< 1	< 1	< 1	< 1	< 1	340 J	< 3300	NA
Ethylbenzene	ug/L	< 1	< 1	< 1	< 1	< 1	330 J	2200 J	NA
Methylene chloride	ug/L	< 1	< 1	< 1	< 1	< 1	< 2100 UJ	< 3900 UJ	NA
4-Methyl-2-pentanone	ug/L	< 10	< 10	< 10	< 10	< 10	750 J	< 33000	NA
Naphthalene	ug/L	NA	NA	NA	NA	NA	24000	70000	NA
Styrene	ug/L	< 1	< 1	< 1	< 1	< 1	< 1700	930 J	NA
Tetrachloroethene	ug/L	< 1	< 1	4.4	4.2	6.6	< 1700	< 3300	NA
Toluene	ug/L	< 1	< 1	< 1	< 1	< 1	14000	80000	NA
1,1,1-Trichloroethane	ug/L	< 1	< 1	0.41 J	0.4 J	0.4 J	6600	23000	NA
Trichloroethene	ug/L	< 1	< 1	3.3	3.3	1.9	< 1700	< 3300	NA
1,1,2-Trichloro-1,2,2-trifluoroethane	ug/L	< 1	< 1	2.6	2.5	< 1	< 1700	< 3300	NA
1,2,4-Trimethylbenzene	ug/L	NA	NA	NA	NA	NA	400 J	1800 J	NA
1,3,5-Trimethylbenzene	ug/L	NA	NA	NA	NA	NA	< 1700	780 J	NA
Vinyl chloride	ug/L	< 1	< 1	0.45 J	0.42 J	< 1	< 1700	< 3300	NA
Xylenes (total)	ug/L	< 2	< 2	< 2	< 2	< 2	< 3300	6300 J	NA
Semi-Volatile Organic Compounds									
Acenaphthylene	ug/L	NA	NA	NA	NA	NA	NA	NA	120
2-Methylnaphthalene	ug/L	NA	NA	NA	NA	NA	NA	NA	370
Naphthalene	ug/L	NA	NA	NA	NA	NA	NA	NA	6000
Phenanthrene	ug/L	NA	NA	NA	NA	NA	NA	NA	55

Table 2-2: CRS Site Elyria - Soil and NAPL Sampling Results Summary

Parameter	Units	GP-47, 4-6'	GP-54, 4-8'	GP-56, 8-9'	GP-57, 4-8'	GP-74, 12-16'	GP-75, 8-10'	GP-80, 12-15'	GP-84, 15-16'	MW-6B DNAPL	MW-6 DNAPL	MW-6 LNAPL
		11/17/2010	11/17/2010	11/17/2010	11/17/2010	11/18/2010	11/18/2010	11/19/2010	11/19/2010	9/29/2010	11/16/2010	11/16/2010
Volatile Organic Compound												
Acetone	mg/kg	< 1.1	0.82 J	< 11	< 620	16 J	< 1.2	< 6	< 62	< 2100	NA	< 2100
Benzene	mg/kg	< 0.26	< 0.91	< 2.7	17 J	7.2	< 0.29	0.48 J	19	320 J	NA	< 520
2-Butanone	mg/kg	< 1.1	0.52 J	< 11	< 620	11 J	< 1.2	0.65 J	7.9 J	< 2100	NA	< 2100
Carbon disulfide	mg/kg	< 0.26	0.15 J	< 2.7	< 150	< 6.4	< 0.29	< 1.5	< 15	< 530	NA	< 520
Cyclohexane	mg/kg	< 0.53	0.16 J	< 5.4	< 310	< 13	< 0.58	< 3	< 31	< 2100	NA	< 2100
1,2-Dichlorobenzene	mg/kg	1.8	0.46 J	0.75 J	< 150	< 6.4	0.17 J	3.7	< 15	< 1000	NA	< 1000
1,3-Dichlorobenzene	mg/kg	0.041 J	0.063 J	< 2.7	< 150	< 6.4	< 0.29	0.051 J	< 15	< 1000	NA	< 1000
1,4-Dichlorobenzene	mg/kg	0.36 B	0.17 J B	< 2.7	< 150	< 6.4	< 0.011 B	0.35 J B	< 15	< 1000	NA	< 1000
1,1-Dichloroethane	mg/kg	< 0.26	< 0.91	< 2.7	< 150	< 6.4	< 0.29	< 1.5	1.6 J	< 530	NA	< 520
1,1-Dichloroethene	mg/kg	< 0.26	0.4 J	< 2.7	< 150	< 6.4	< 0.29	< 1.5	< 15	270 J	NA	< 520
cis-1,2-Dichloroethene	mg/kg	0.03 J	1.1	0.16 J	32 J	5.6 J	0.12 J	0.67 J	11 J	4400	NA	< 260
Ethylbenzene	mg/kg	0.59	0.32 J	12	300	9.4	1.6	19	29	2500	NA	< 520
Isopropylbenzene	mg/kg	0.066 J	0.053 J	0.25 J	9.6 J	< 6.4	0.2 J	2.7	< 15	86 J	NA	< 1000
Methyl acetate	mg/kg	< 0.53	0.21 J	< 5.4	< 310	< 13	0.055 J	< 3	< 31	< 1000	NA	< 1000
Methylcyclohexane	mg/kg	0.025 J	0.28 J	0.22 J	25 J	< 13	0.098 J	0.23 J	< 31	360 J	NA	< 520
4-Methyl-2-pentanone	mg/kg	< 1.1	< 3.6	< 11	< 620	1.5 J	< 1.2	< 6	< 62	< 2100	NA	< 2100
Naphthalene	mg/kg	2.5 B	0.23 J B	86 B	49 J B	100 B	1.1 B	3.9 B	490 B	92000 E	NA	28000 B
Styrene	mg/kg	< 0.26	< 0.91	< 2.7	< 150	< 6.4	< 0.29	< 1.5	3.6 J	960	NA	590
Tetrachloroethene	mg/kg	0.13 J	11	0.22 J	13 J	< 6.4	0.05 J	0.092 J	< 15	140 J	NA	< 520
Toluene	mg/kg	0.44	0.43 J	32	1600	16	1.4	5.5	120	32000	NA	440 J
1,2,4-Trichlorobenzene	mg/kg	0.015 J	0.14 J	< 2.7	< 150	< 6.4	0.022 J	0.12 J	< 15	< 1000	NA	< 1000
1,1,1-Trichloroethane	mg/kg	0.14 J	17	< 2.7	160	< 6.4	0.072 J	< 1.5	9.9 J	4200	NA	< 520
Trichloroethene	mg/kg	1	17	< 2.7	20 J	< 6.4	0.044 J	0.33 J	0.74 J	< 530	NA	< 520
1,2,4-Trimethylbenzene	mg/kg	0.72	1.1	4.4	25 J	1.9 J	2.6	45	14 J	3400	NA	1000
1,3,5-Trimethylbenzene	mg/kg	0.49	1.2	1.5 J	8.4 J	0.8 J	0.75	14	5.2 J	1200	NA	820 J
Xylenes (total)	mg/kg	6.3	6.6	43	1300	15	11	85	63	7200	NA	430 J
Semi-Volatile Organic Compounds												
Acenaphthene	mg/kg	9.3	< 0.074	0.12	0.95	1.1	0.016	< 0.16	7.6	NA	52	NA
Acenaphthylene	mg/kg	36	2.4	0.16	8.8	3.1	0.035	< 0.16	5.2	NA	380	NA
Anthracene	mg/kg	20	0.51	0.36	8.5	3.3	0.017	< 0.16	20	NA	310	NA
Benzo(a)anthracene	mg/kg	12	2.1	0.28	32	2.4	0.086	< 0.16	13	NA	< 25	NA
Benzo(a)pyrene	mg/kg	15	3.6	0.3	79	2.3	0.069	0.22	12	NA	260	NA
Benzo(b)fluoranthene	mg/kg	12	4.1	0.26	67	1.5	0.25	0.52	8.1	NA	200	NA
Benzo(ghi)perylene	mg/kg	14	6.3	0.24	100	1.3	0.5	0.63	6.8	NA	150	NA
Benzo(k)fluoranthene	mg/kg	3.5	1.5	0.1	25	< 0.69	0.095	< 0.16	4.5	NA	110	NA
1,1'-Biphenyl	mg/kg	18	< 0.55	0.22	2.4 J	4.2 J	0.11 J	< 1.2	10	NA	130 J	NA
bis(2-Ethylhexyl) phthalate	mg/kg	< 5.3	< 2.4 B	0.089 J	4	< 5.2	2.7	3.7 B	< 7.9	NA	< 180	NA
Butyl benzyl phthalate	mg/kg	1.8 J	0.47 J	< 0.14	< 4	< 5.2	< 0.12	0.92 J	< 7.9	NA	< 180	NA
Chrysene	mg/kg	13	2.5	0.32	42	2.2	0.18	0.32	12	NA	< 25	NA
Dibenz(a,h)anthracene	mg/kg	1.3	< 0.074	0.034	13	< 0.69	< 0.037	< 0.16	< 1	NA	< 25	NA
2,4-Dimethylphenol	mg/kg	< 16	< 1.7	< 0.41	< 12	< 16	0.3 J	< 3.6	< 24	NA	< 550	NA
Fluoranthene	mg/kg	48	2.9	1.1	38	5.6	0.28	0.29	29	NA	600	NA
Fluorene	mg/kg	35	0.19	0.56	4.6	4.1	0.041	< 0.16	15	NA	280	NA
Indeno(1,2,3-cd)pyrene	mg/kg	8.2	3.5	0.15	60	0.88	0.23	0.33	4.1	NA	91	NA
Isophorone	mg/kg	< 5.3	< 0.55	< 0.14	1.1 J	< 5.2	< 0.12	< 1.2	< 7.9	NA	< 180	NA
2-Methylnaphthalene	mg/kg	51	0.14	0.51	6.7	17	0.24	3.1	57	NA	790	NA
2-Methylphenol	mg/kg	< 21	< 2.2	< 0.54	< 16	< 21	1.1	< 4.8	< 31	NA	< 740	NA
4-Methylphenol	mg/kg	< 21	< 2.2	< 0.54	< 16	< 21	0.99 #	< 4.8	< 31	NA	< 740	NA
Naphthalene	mg/kg	9.1 B	0.12	0.33 B	3.7 B	130 B	0.58 B	2.6	250	NA	3400	NA
Phenanthrene	mg/kg	120	0.58	3.1	35	15	0.32	0.27	72	NA	1200	NA
Pyrene	mg/kg	69	6	1.7	86	8.1	0.43	0.47	47	NA	850	NA
Aroclor 1242	mg/kg	< 0.35	< 0.037	< 0.036	0.25	< 0.043	0.25	< 0.04	< 0.042	NA	NA	NA
Aroclor 1254	mg/kg	< 0.35	0.045	< 0.036	0.41	< 0.043	0.31	0.15	< 0.042	NA	NA	NA

NOTES:

J-Estimated result. Result is less than the reporting limit.

B-Method blank contamination. The associated method blank contains the target analyte at a reportable level.

#-This value represents a probably combination of 3-methylphenol and 4-methylphenol

E-Estimated result. Result concentration exceeds calibration range.

Appendix A: Field Sampling Plan (FSP)

CDROM

FIELD SAMPLING PLAN
FOR THE
REMEDIAL DESIGN / REMEDIAL ACTION
CHEMICAL RECOVERY SYSTEMS, INC. SITE

Prepared for
CRS Site RD/RA Performing Parties
Chemical Recovery Systems, Inc. (CRS) Site
Elyria, Ohio
September 2010

Prepared by:
Brown and Caldwell
4700 Lakehurst Court, Suite 100
Dublin, Ohio 43016

139452

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FIELD SAMPLING PLAN

1. INTRODUCTION

This document presents the Field Sampling Plan (FSP) for field activities associated with Remedial Design (RD), and Remedial Action (RA) at the Chemical Recovery Systems, Inc. (CRS) site (the Site). Updates to this FSP may be made periodically if field activities are required that are not currently anticipated. These activities will be undertaken on behalf of the CRS Site RD/RA Group Performing Parties (Performing Parties). This work is being performed to meet the requirement of the Consent Decree 1:10-cv-00996 (CD), signed by USEPA and the Performing Parties, and entered by the Court on July 18, 2010, the Record of Decision (ROD), and the Statement of Work (SOW) for the Site.

This FSP has been prepared in general conformance to relevant U.S. Environmental Protection Agency (USEPA) and the Ohio EPA (OEPA) guidance, including “Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA” (USEPA, 1988).

The overall approach and objectives of the remedial design activities are discussed in the RD Work Plan (RDWP) (Brown and Caldwell, 2010). The Data Quality Objectives (DQOs) and overall project Quality Assurance (QA) objectives and procedures are presented in the Quality Assurance Project Plan (QAPP), included as Appendix B to the RDWP. A site-specific Health and Safety Plan (HASP) developed for the field activities associated with the RD is included as Appendix C to the RDWP.

This FSP describes the project sampling rationale and procedures that will result in data which meets the project objectives. The FSP is organized into the following sections:

- Section 1.0 - Introduction
- Section 2.0 - Sampling and Testing Objectives
- Section 3.0 - Sampling Location and Frequency
- Section 4.0 - Sample Designation and Documentation
- Section 5.0 - Sample Equipment and Procedures
- Section 6.0 - Sample Handling and Custody
- Section 7.0 - References

1.1 Background and History

The Site is located at 142 Locust Street (formerly Maple Street) in Elyria, Lorain County, Ohio (Figure 1-1) and is located in a predominantly industrial area of Elyria, Ohio. The western boundary of the Site runs along the East Branch of the Black River (River). To the north and east, the Site is bordered by the BASF Corporation (formerly Engelhard Corporation and prior to that the Harshaw Chemical Company). Locust Street runs along the eastern boundary of the CRS Site. The M&M Aluminum Siding property to the south was recently acquired by BASF for an expansion project. Figure 1-2 is a Site layout drawing including on-site features and property.

Two buildings (located on the southeast corner of the Site) remain on the property. One building is the former warehouse and office building and the other is a portion of the Rodney Hunt Still Building. These buildings have historically been leased and utilized for storage of carpeting and other miscellaneous items by M&M Improvement Company. A concrete slab foundation of a former building is located in the northwest

corner of the property. In addition, a concrete slab foundation for the Brighton Still building, and the secondary containment dike for a former AST farm remain in the northwestern corner of the Site (all tanks have been removed from the AST farm). Two sumps remain onsite, one sump is located in the Rodney Hunt Building and the other, is located in the former Brighton Still Building. Four pipes (subsurface conduits) are located along the western boundary of the property along the River. The primary subsurface conduit is a storm sewer pipe that runs from Locust Street under the Site to the River. A manhole on Locust Street provides access to the storm sewer, which drains run-off from BASF and other commercial and industrial sites comprising approximately one fourth of the downtown Elyria area. Cars, trucks, wood waste, and other debris are also located on the property.

The working area of the Site is essentially level and consists of a grassy cover with patches of gravel and asphalt. Surface drainage is westward, towards the East Branch of the Black River (the River). The western edge of the Site is heavily vegetated with a steep grade from the working area to the East Bank of the Black River. The property is fenced on the northern, eastern, and southern sides, restricting casual access to the Site.

Based on Sanborn Maps dating as far back as 1884, the Site has been in industrial use since the later 1800's. In 1960, Russell Obitts began operations by leasing lots from the Swiers Coal Company. On March 23, 1965, Dorothy K. Dubena purchased the parcels from the Swiers Coal Company. Dorothy Dubena married Russell Obitts and became Dorothy Obitts. Two companies were owned by Mr. Obitts and operated at this Site from 1960 through 1974. Obitts Chemical Services operated a solvent reclamation facility. Obitts Chemical Company sold the reclaimed solvents to industry. Obitts obtained used, "scrap" or "spent" organic solvents from various companies. After distilling the "dirty" solvents, the "cleaned" reclaimed solvents were repackaged and sold. The solvents were transported to and from the Site in 55-gallon drums or by tanker trucks.

From 1974 to 1981, CRS continued in the business of solvent reclamation and sales. The solvents continued to be stored in 55-gallon drums, ASTs, and tanker trucks. It is alleged that several spills and releases occurred during this time. In 1980, the USEPA filed a lawsuit against CRS, requiring the facility owners to abate environmental issues identified at the Site. In response to this lawsuit, CRS ceased the receipt, processing, and storage of spent solvents and removed tanks, drums, and other solvent containers from the Site in 1981. CRS ceased operations and filed for bankruptcy prior to 1983.

FIELD SAMPLING PLAN

2. SAMPLING AND TESTING OBJECTIVES

The objectives of the sampling program are to gather data of adequate technical content, quality, and quantity to support the RD/RA for the Site. Samples will be collected at designated locations to ensure that a sufficient quantity of data is obtained to meet the goals of the RD/RA. The overall objective for each of the sampling tasks is to obtain data of sufficient quality and quantity to evaluate the current conditions of the Site and to verify the effectiveness of the remedy.

The QAPP, provided as a companion document, outlines the data quality objectives and the corresponding quality assurance standards by which all sample acquisition and testing will be conducted as part of the field program. The QAPP presents the detailed, site-specific laboratory protocols to be followed to ensure the quality and integrity of the remedial design activities data, along with the accuracy and precision of the testing/analyses and the representativeness and completeness of the data.

FIELD SAMPLING PLAN

3. SAMPLING LOCATION AND FREQUENCY

This section discusses sampling locations and frequencies for the RD activities. Detailed sampling and field procedures are provided in Sections 4 and 5.

3.1 Investigation/Site Closure Activities

The following paragraphs summarize the proposed investigations to support the RD.

3.1.1 Soil Boring/Monitoring Well Installation

Several monitoring wells will be installed as part of the RD/RA. If additional monitoring wells or replacement wells are determined to be necessary, they will be installed consistent with those wells installed during the RI/FS. Wells will be constructed of two-inch diameter schedule 40 PVC well casing and screen. The well screen will include 0.010-slot well screen and a screen length of 5 to 15 feet, depending on the length of the zone to be monitored. The well will be installed such that the shallow water table is contained within the screened interval where a water table exists. Wells will be installed through 4.25-inch I.D. Hollow stem augers (HSAs), if the well is placed in unconsolidated material, to create an approximately eight-inch diameter borehole. Well construction will include a sand/filter pack around the screened portion of the well to a height of one to two feet above the top of the screen, followed by a one- to two-foot bentonite seal, then grouted to ground surface. A measurement reference point will be marked on the top of the inner PVC well casing. Surface completion will include a steel, lockable, stick-up protective casing secured in a concrete surface pad.

During drilling in unconsolidated material, the soils will be continuously sampled via the SPT method (ASTM D1586) to establish the lithology of the subsurface and the location of the shallow water table. Following installation, the new monitoring well(s) will be developed. Monitoring well installation and development will be in accordance with those procedures described in SOP No. 1 in Attachment A. Soil cuttings and development water will be managed in accordance with procedures described in Section 5-7.

Wells to be completed in competent rock will utilize one or more rock drilling techniques such as air rotary, or wire-line. The upper, unconsolidated material will be cased off from the bedrock borings using HSA until refusal is encountered. A casing will be placed from the grade to the top of competent bedrock to ensure that contaminants present in the overburden or in perched water above bedrock does not enter the bedrock zone of the well. The casing will be grouted in place at the bedrock surface using a cement-bentonite grout. This grouting will be allowed to set for a minimum of 24-hours, after which point a borehole will be drilled through the hardened grout and to the targeted total depth of core boring in bedrock.

Rock at each coring location will be cored using a wire-line or similar drilling methodology following ASTM D5876. Core runs will be advanced in 10-foot increments using air. If circulation cannot be maintained solely through the use of air, the determination may be made to use potable water as a drilling fluid. If this is the case, the amount of potable water used will be kept to a minimum and the gallons used for each core run will be recorded in the boring log. Any water or air that will be used inside the borehole will be analyzed or filtered, respectively, to prevent addition of contaminated material into the borehole. Care will be exercised while drilling to limit the down pressure on the drill stem to avoid creating drilling induced fractures immediately adjacent to the borehole.

Each rock core will be stacked in stratigraphic order in a core box. Major core breaks, the start and stop of each run, and the time of each run will be recorded on the core box. The storage and transport of rock cores will be in conformance with ASTM D5079 Standard Practice for the Transporting and Storage of Rock Core Samples.

A field geologist will log each rock core noting the rock type, field hardness, weathering structure, color, texture, mineralogy, discontinuity spacing, coatings/infillings, attitude, shape, and any other identified discrete features. The percent recovery (sum total length of recovered core fitted together, divided by the length of attempted core run) and rock quality designation (RQD) (sum length of hard, sound core pieces 4 inches and longer, divided by the length of attempted core run) will be calculated and recorded on the log for each core run along with the starting/ending depths and times, amount of drilling water used during the core run, and results of a PID screen over the length of the core.

Following each 10 foot core run, the boring will be measured for total depth with a clean, weighted tape. A decontaminated, 5-foot, pre-packed screen with packer will be attached to the drill stem and lowered to the total depth of the boring to create a temporary well. The packer will be placed to isolate the water interval around the well screen. Once the packer is in place, the water level inside the well screen and in the annulus outside the drill stem will be measured and recorded. A Grundfos Redi-flo2 or equivalent pump will be lowered into the temporary well screen. Low-flow groundwater sampling (purge rate less than 500 milliliters per minute and ideally at 100 milliliters per minute) will be performed; the overfilling of the sample collection bottles will be prevented by controlling the flow rate of the pumping. The following water-quality parameters will be monitored during purging to verify stabilization prior to sampling: temperature, pH, and specific conductance. Turbidity, oxidation-reduction potential, and dissolved oxygen will be recorded but not considered parameters for stabilization. Water quality parameters will be recorded on standard groundwater-sampling data sheets along with the time associated with each monitoring interval and the total volume removed. If any water has been added during drilling, a similar amount will be removed prior to sampling. Groundwater samples will be collected for VOC analysis once the water quality parameters have stabilized to the criteria specified in Ohio Environmental Protection Agency's (OEPA's) Technical Guidance Manual for Hydrogeologic Investigations. Each groundwater sample will be labeled with the core boring location followed by the screen interval in parentheses, the date and time of the sample, sample preservative, requested analysis, and sampler's initials. Samples will be packaged and placed on ice in a cooler for delivery to the laboratory under chain-of-custody procedures. All purge water will be containerized and transported to the onsite investigation derived waste (IDW) staging area.

Following installation, the horizontal/vertical position of the well will be surveyed by a licensed Ohio surveyor in accordance with the QA procedures described in the QAPP. The elevation of the ground surface and the measurement reference point on top of the inner PVC well casing will also be surveyed for elevation.

3.1.2 Groundwater Sampling

Groundwater sampling will be conducted in accordance with the QAPP and SOP No. 2 in Attachment A. Groundwater sampling will generally use "low-flow" purging and sampling techniques, depending on the recovery rates of the wells sampled; hand bailers may also be utilized to collect samples as well as other procedures discussed in SOP No. 2. Groundwater samples collected for analysis will be sent to the analytical laboratory to be analyzed for the specified parameters, which might include some combination of volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), metals, and polychlorinated biphenyls (PCBs). Field parameters measured during purging/sampling may include pH, temperature, dissolved oxygen (DO), specific conductance and turbidity. Purge water will be managed in accordance with the procedures described in Section 5-7.

3.1.3 Monitoring Well Abandonment

Monitoring well abandonment, if performed, will be in conformance with procedures described in the document entitled “State of Ohio Technical Guidance for Sealing Unused Wells”, dated 1996 (Attachment B), and in accordance with OAC 3745-9. The Technical Guidance additionally calls for completing a form for each well abandoned and submitting it to the Ohio Department of Natural Resources (ODNR). Copies of the well abandonment form(s) will also be submitted to USEPA.

Well materials removed during well abandonment will be managed in accordance with procedures described in Section 5-7.

3.1.4 Soil Sampling

The extent of soil excavation that will be necessary in the northwest corner of the Site was defined during the RI. Post-excavation sampling will be conducted to document the concentrations of chemicals of concern (COCs) left in the soil, but will not be used to direct further soil removal. The rationale for determining the size of the excavation will be defined in the RD and will be based on existing data contained in the RI/FS Report and the limits defined in the SOW.

The precise post-excavation sampling strategy will be provided in the RD. These samples will be submitted to the laboratory for analysis. Analyses will likely include a combination of metals, VOCs, SVOCs, as well as PCBs. Analytical procedures will be consistent with those described in the QAPP. The post-excavation sample data will be shared and discussed with U.S. EPA prior to initiating backfilling of the excavation.

3.1.5 Demolition

Two on-site buildings/structures (the office/warehouse building and the shell of the former Rodney Hunt still building) will be demolished. Metal, glass, and asbestos containing materials will be disposed of off-site. In addition, wood chips and other vegetative debris in the former aboveground storage tank area will be disposed of off-site. Other building materials may be crushed and used on site as fill material. U.S. EPA approved sampling methods will be utilized to characterize the demolition materials generated during demolition activities for off-site disposal or for use on-site, where appropriate, for leveling, filling, and grading.

3.1.6 Closure of On-Site Sumps

Two on-site sumps will be removed or properly sealed in place. The Brighton Still sump will be removed for offsite disposal. At least one soil sample will be collected from beneath the sump to characterize the soil after removal of this sump. The sample will be analyzed for metals, VOCs and SVOCs.

Samples of soil near the Rodney Hunt Still sump will be collected for metals, VOCs, and SVOCs analyses. Soil cleanup levels in the areas of the Rodney Hunt Still will be proposed in a demonstration to be protective of groundwater. If the demonstration is approved, the sump will be backfilled in accordance with the SOW. If the demonstration is not approved, the sump will be excavated and materials will be disposed of off-site. If removal is necessary, at least one soil sample will be collected from beneath the sump to characterize the soil after removal of this sump. The sample will be analyzed for metals, VOCs and SVOCs.

3.2 Contingency Investigations

In addition to those investigations defined above, additional, or contingency investigations may also be

necessary during the RD/RA, depending on the results of the initial investigations and evaluations. These contingency investigations may include additional monitoring well installation, groundwater sampling, monitoring well abandonment, and post-excavation sampling. The field procedures associated with these contingency investigations are discussed in general terms in the above subsections, so that if any aspect of these investigations are realized, this FSP will not need significant revisions.

FIELD SAMPLING PLAN

4. SAMPLE DESIGNATION AND DOCUMENTATION

A key aspect of field sampling quality assurance involves the implementation of sampling documentation procedures. Proper development and implementation of these procedures ensures the integrity of a sample from collection to data reporting.

4.1 Field Sample Designation

Each sample collected during the pre-design field activities will receive a unique sample number. This sample number will be essential for tracking samples in the field and at the laboratory, and managing the resulting data.

In order to identify each sample collected, a sample-tracking scheme will be implemented which allows all samples to be traced to a specific location (e.g., well, soil boring, etc.), matrix, depth (as appropriate), and date of collection. These procedures are described in the QAPP and summarized below.

The method of identification of a sample depends on the type of measurement or analysis performed. When field screening measurements (e.g., pH, dissolved oxygen, or turbidity) are made, data are recorded directly in logbooks or on field investigation forms. Identifying information such as project name, station number, station location, date and time, name of sampler, field observations, remarks, or other pertinent information will be recorded.

Samples collected for laboratory analysis during the field investigation will be specifically designated for unique identification. Each sample will be designated by an alpha-numeric code which will identify the sampling location, type or as necessary depth.

Aqueous and solid samples collected as a part of the work will be assigned unique sample identifiers. The sample identifiers are required in order to identify and track each of the samples collected for analysis. Associated field QA/QC samples such as duplicates and field blanks will be further identified adding the date of collection to the sample name as shown below, and as needed a number will be added sequentially to distinguish the samples.

Each of the samples will be identified by a unique alpha-numeric code that indicates the particular sample type, location, and date. The format of the code is as follows:

The three codes that make up the sample identifier are described as follows:

1. The Site name – CRS (Chemical Recovery Systems, Inc.);
2. The medium/sample type codes are listed below:
 - MW - Groundwater sample taken from a monitoring well;
 - SW - Surface water sample;
 - SP - Seep sample;
 - SED - Sediment sample;
 - S - Soil sample
 - DW - Drummed waste sample;
 - W - Waste sample;

- SB - soil boring sample;
 - TB - Trip Blank;
 - FB - Field Blank sample;
 - DUP - Duplicate sample; and
 - MS/MSD – Matrix Spike/Matrix Spike Duplicate sample.
3. The location code will be keyed to the specific sample designation.

The following is an example of a sample identifier that will be used for samples collected for geotechnical laboratory analysis:

- CRS-SB-10B-2-4: indicating that this is the second soil sample was collected at soil boring location CRS-SB-10 from a depth of 2 to 4 feet below ground surface.

4.2 Laboratory Sample Identification Number

The analytical laboratories will assign a unique I.D. number to each sample submitted for testing. The laboratory will submit a deliverable to BC that provides a cross-reference between the laboratory sample I.D. and the field sample I.D.

4.3 Field Sampling Documentation

A critical aspect of data quality involves the development, use, and maintenance of a field sampling documentation system. A strict and thorough sampling documentation system will be utilized during sampling conducted at the Site. This documentation, which includes proper labeling of sample containers and field logbook entries, is essential for data tracking, sample custody, and overall data quality assurance.

4.3.1 Sample Labels

Sample labels are required on sample containers for the primary purpose of sample identification. Specific field data need not be recorded on the labels as they will be recorded on field data sheets and/or in the field logbook. The sample labels will contain the following information:

- Sample identification (see Section 4.1);
- Depth of sample (if appropriate);
- Analysis/test to be performed;
- An “up” arrow (Shelby tube samples only)
- Preservative (if required);
- Project name and number;
- Date and time of sample collection; and
- Initials of Sampler

4.3.2 Field Logbook

A bound weatherproof logbook, dedicated to the Site, will be kept by the sampling personnel. The Site logbook is a controlled document that records major on-site activities during the field investigation. At a minimum, the Site logbook will include a summary of sampling identifiers and shipment information, visitor's names and arrival/departure times, community contacts, and other site-specific information determined by

the sampling personnel to be noteworthy. In addition, prior to field work each day, the personnel Site, the proposed activities, and the weather will be recorded in the Site logbook. Discussions of program activities, field difficulties/problems, and deviations from the FSP, QAPP and/or other Site plans (with justification) must also be included in the logbook, along with corresponding times.

The sampling team or any individual performing a particular field investigation activity (e.g., soil or groundwater sampling) will be required to maintain a field logbook. Each logbook will be controlled and assigned a unique sequential identification by the sampling personnel.

Pertinent information to be recorded in field logbooks includes information that is necessary to reconstruct the investigative/sampling operations. Documentation of sample activities in the field logbook will be completed immediately after sampling at the location of sample collection. Logbook entries will contain sample information, including sample number, collection time, location, descriptions, field measurements, and other site- or sample-specific observations. Difficulties with sample recovery and other field observations (e.g., staining, visible contamination, etc.) will be noted if encountered.

If photographs are taken as part of the documentation procedure, the name of the photographer, the date, the time, and a description of the photo (including direction and scale, if applicable) will be entered sequentially in the field logbook as the photographs are taken. Once downloaded, the photographs will be numbered in correspondence to the logbook numbers, and the above information will be placed in a photographic log filed with the photographs and/or placed on the back of the photograph.

The field logbooks will have the name of the Site and project written on the cover and inside the cover. The date, page number and initials of the primary field note transcriber will be written atop each page during the day the entries are made. Corrections to the logbooks will consist of a single strike line through the incorrect entry, the new accurate information, the initials of the corrector, and the date of amendment. Any blank spaces/pages in the logbooks will be crossed out with a single strike mark and signed by the person making the notation.

4.3.3 Field Forms

During certain sampling events, specific field forms may be used to record field data. An example is for groundwater sampling where well-specific field forms may be used to record the purging and sampling data. However, basic sampling information will still be recorded in the field logbook.

FIELD SAMPLING PLAN

5. SAMPLING EQUIPMENT AND PROCEDURES

5.1 Sample Collection Equipment

To ensure that data generated for the remedial design are valid, consistent, and usable, BC will implement specific sample collection requirements. These requirements focus on the use of appropriate sample collection equipment and set forth specific procedures for sample collection. Also discussed are the proposed decontamination procedures and management of IDW.

5.1.1 Equipment for Sampling Soils

Various pieces of field equipment that may be used to sample soils at the Site are described below.

- Scoops and Shovels

Scoops and shovels are used to collect surface soils or sediments. Scoops and shovels are made of a variety of materials including stainless steel, wood, plastic, or Teflon®. Scoops or shovels may be used to collect shallow bulk samples for geotechnical testing.

- Hand Auger

The hand-powered auger consists of a steel drill bit at the end of a bucket, a drill rod and a T-shaped handle. The auger is used to drill a borehole to a desired depth, usually not more than 4 feet below the surface (depending upon the material encountered). The soil sample is brought to the surface when the auger is withdrawn.

- Soil Corer

The soil corer consists of a small diameter, hollow, thin-walled metal tube. Their length can vary from six inches to two feet. It can be used to obtain an undisturbed soil profile sample from the surface to a maximum depth of approximately eight feet. The soil corer can be driven either manually by a slide hammer, or using a gas or electric powered hammer drill. Soil corer and slide hammer manufacturers include AMS. Hammer drill manufacturers include Bosch.

- Split Spoon

Split spoon samplers are used to collect soil samples from a wide variety of soil types at greater depths than obtainable with most other soil sampling devices. A split spoon sampler consists of a heavy steel sampling tube that can be split longitudinally into two equal halves. Split spoons and Shelby tubes (below) are most commonly used when drilling borings with a hollow stem auger drill rig. The split spoon is attached to a drill rod and is forced into the ground by hammering in accordance with ASTM Method D1586. After the desired depth is reached, the split spoon is extracted from the ground and opened to obtain a soil profile sample.

- Shelby Tube

A Shelby tube is used to obtain an undisturbed sample of soil for determining geotechnical characteristics. It is constructed of metal and has an outside diameter of 2 to 5 inches and a length of 24 to 54 inches. The sampler is advanced through the soil without rotation in a smooth motion. When retrieved, the ends of the sampler are capped with wax, and the sample is sent to the geotechnical laboratory for testing. Shelby tube sampling will be performed in accordance with ASTM Method D1587.

- Macro-Core Sampler

The macro-core sampler is used when drilling soil borings with the Geoprobe®. The sampler consists of a four-foot long, 2-inch diameter stainless steel barrel with a threaded cutting shoe at its base. Soil samples are collected by attaching the sampler to push rods and pushing or hammering the sampler into the subsurface using the hydraulics on the Geoprobe® rig. The soil samples are contained in disposable, clear acetate liners within the drive barrel. The liner is replaced after each sample is obtained.

- Large Core Sampler

The large core sampler is also used with the Geoprobe® and is useful when caving of the boring occurs. The sampler consists of a two-foot long, 1-3/8-inch-diameter stainless steel barrel with a threaded cutting shoe at its base. It is a piston-type sampler that recovers soil from discrete depths. Soil samples are collected by attaching the sampler to push rods used to advance the sealed sampler to the top of the depth interval of interest, then releasing a stop pin from the drive head within the push rods. Once the stop pin is released, the sampler is advanced an additional 24 inches. As the sampler is advanced, the drive point/piston retracts allowing the soil to enter the sampler. The soil samples are contained in disposable, clear liners within the drive barrel.

5.1.2 Equipment for Sampling Groundwater

Various pieces of field equipment that may be used to sample groundwater at the Site are described below.

- Bailer

A bailer is a cylindrical device with a check valve that is made of Teflon®, PVC or stainless steel. It is designed to collect liquid samples from groundwater monitoring wells, and may also be used to sample liquids in pits or tanks. Bailers may be dedicated, field cleaned, or disposable. For groundwater sampling at the Site, bottom-emptying, dedicated/disposable Teflon® bailers will be used to sample each well scheduled to be sampled.

- Peristaltic Pump and Tubing

A peristaltic pump may be used to purge/sample the shallow wells at the Site. The pump consists of a circular series of rollers that successively squeeze a section of flexible tubing, creating a vacuum. A section of polyethylene tubing is connected to the pump silicone tubing and lowered into the well to the desired depth. Flow is regulated with a rheostat-type controller located on the pump. The pumps run on internal batteries, or external AC or 12 volt DC power. Dedicated/disposable tubing will be used to sample each well at the Site.

- Submersible Pump and Tubing

A Grundfos® 2-inch diameter submersible electric pump or similar DC submersible pump may be used to sample wells at the Site. The Grundfos® pump is constructed of stainless steel with a Teflon® impeller, and is easily decontaminated between wells. Other DC pumps that might be used will typically have a plastic or stainless steel body with plastic or Teflon impellers. Flow is regulated with a rheostat-type controller located at the surface. AC power is usually provided by a generator. DC power is typically supplied by a 12 volt battery. Polyethylene tubing connected to the pump will be dedicated/disposable and changed between well locations.

5.2 Field Instrumentation

Brown and Caldwell may utilize various field instruments at the Site. All instruments will be operated according to the manufacturer's specifications. Instruments requiring calibration will be calibrated prior to daily use according to the manufacturer's recommendations. Calibration results will be documented in the field logbook.

5.2.1 Interface Probe

An interface probe (IP) will be used to measure liquid levels in monitoring wells and to measure LNAPL/DNAPL thickness, if any. Measurements obtained using an IP will be documented in the field logbook.

The depth to liquid(s) will be measured in existing monitoring wells using an IP. The probe will be lowered into the well until the meter indicates liquid has been contacted via emission of an audible tone. The IP emits different audible tones when encountering LNAPL/DNAPL versus groundwater. Generally, a solid tone indicates LNAPL/DNAPL, whereas an intermittent tone indicates groundwater. The depth from the surveyed reference mark atop the well inner casing to the top of the first liquid encountered will be measured on the tape at least three times or until a consistent value is obtained. The value will be recorded to the nearest 0.01 feet on field data sheets and/or the field logbook, along with the type of liquid encountered (LNAPL/DNAPL or groundwater). The procedure will be repeated to measure the depth to the LNAPL/DNAPL/groundwater interface (i.e., the groundwater surface) where both phases are present. Due to the difficulties sometimes encountered in attempting to obtain an accurate depth to the LNAPL/DNAPL/groundwater interface, care will be taken when measuring this depth.

5.2.2 Groundwater Multi-Parameter Meter

Groundwater samples will be field tested with a multi-parameter meter in a flow-through cell. Groundwater will be tested during purging (in accordance with the procedure used for low-flow sampling if this technique is used) and just prior to sample collection to provide an indication of field parameter stability over time. The meter will be used to measure pH, specific conductance, temperature, dissolved oxygen, and turbidity. A commercially available instrument will be used. All parameter values will be reported in the field logbook and/or field sample data sheets. Operation and calibration will be in accordance with instrument's owner manual. The instrument will be calibrated at a minimum of before each day of use.

5.2.3 Photoionization Detector

A photoionization detector (PID) may be used to detect total organic vapors during various field activities for the health and safety of field personnel. Use of the PID is described in the HASP.

5.2.4 Multi-Gas Detector

A multi-gas detector may be used to detect methane, hydrogen sulfide and the lower explosive limit (LEL) during various field activities for the health and safety of field personnel. Records will be maintained for all measurements taken including measurements taken during boring advancement. Use of the multi-gas detector is described in the HASP.

5.3 Sample Collection Procedures

5.3.1 Soil Sampling

Sampling during the investigation may include Geoprobe® soil borings, hollow-stem-auger (HSA) drill rig soil borings, and rock coring/drilling rigs. The sampling procedures are described in the following paragraphs. Upon completion of the field program, if necessary, each soil boring location will be surveyed for horizontal and vertical position by a licensed Ohio surveyor in accordance with the QA procedures described in the QAPP.

5.3.1.1 Geoprobe® Soil Borings

Geoprobe® soil borings will be sampled continuously from the ground surface to the total depth of the boring. Soil samples will be collected in four-foot-long macro-core samplers. An acetate liner will be placed within the sampler. Upon recovery, the sampler will be opened and the liner containing the soil will be removed.

The driller, or a BC representative, will slit the liner longitudinally and BC's field geologist will log the color, texture, and moisture content of the sample. This information, as well as the percent of recovery in the liner and sample depth, will be recorded in the field logbook. Any visual or other evidence of contamination such as staining or odors will also be recorded. Each boring will be clearly identified, and recorded.

Upon completion of each Geoprobe® boring, the boring will be backfilled with bentonite pellets or chips and hydrated. Soil boring cuttings will be spread on the ground surface unless they contain waste material or evidence of contamination (e.g., odor, staining, etc.), then they will be containerized as described in Section 5.7.

5.3.1.2 Soil Borings

Soil samples from select borings may be collected using standard hollow-stem-auger methods and split-spoon samplers. It is anticipated that any auger drilling will be performed with 4.25-inch inside-diameter, hollow-stem augers. The intervals identified for testing will be based on the lithology of the boring, and discussions with BC's Project Manager. The actual depths of the samples to be collected cannot be pre-determined in this FSP.

The boring at each location will be continuously sampled using split spoons in accordance with the SPT via ASTM Method D1586 (see Attachment A). This method consists of driving the split spoon sampler using a 140-pound weight (or auto-hammer) and 30-inch drop. The number of blows needed to drive the split spoon each six inches will be recorded.

Upon retrieving each split spoon, the SPT blow counts will be recorded in the field logbook, along with the percent recovery in the split spoon and the description of the soil, including depth of sample, color, texture, grain size, evidence of contamination, etc. A representative portion of each split spoon sample will be retained in a labeled zip-lock storage bag for head-space analysis.

Upon completion of each boring location, the boring will be backfilled with a bentonite/cement slurry via the tremie method to grade as the augers are removed. Soil boring cuttings will be spread on the ground surface unless they contain waste material or evidence of contamination (e.g., odor, staining, etc.), then they will be containerized as described in Section 5.7.

5.3.2 Groundwater Sampling

Groundwater sampling will be performed in accordance with SOP No. 2 in Attachment A. Groundwater sampling will consist of four tasks:

1. Water level measurement and immiscible layer detection;

2. Well purging;
3. Field testing for pH, specific conductance, temperature, dissolved oxygen, and turbidity; and
4. Sampling.

Before each well is sampled, the well will be inspected for integrity. Any non-dedicated sampling equipment will be decontaminated before sampling each well following the procedures described below. During a complete Site sampling event, a round of liquid level measurements will be obtained from all Site wells prior to purging/sampling begins. Measurements will be made consecutively in a minimal amount of time to avoid any effects of temporal fluctuation in water levels.

Wells will be purged and sampled with a submersible or peristaltic pump. Wells may also be sampled with a disposable bailer. Bottom-emptying bailers will be used when bailer sampling of VOCs is necessary.

During well purging, wells that recover in a reasonable amount of time will be purged of three well volumes and sampled as soon as possible thereafter. Low yielding wells will be purged to dryness. All wells will be sampled within 24 hours of purging. Field parameters such as pH, conductivity, temperature and turbidity of the groundwater will be monitored periodically during purging, and measurements will be noted in the field logbook and/or field forms.

Following purging, the well will be sampled according to SOP No. 2 in Attachment A which also discusses the prioritized order of collection of samples for various parameters. Samples for analysis for dissolved metals, if required, will be field filtered following the procedures specified in SOP No. 2.

5.4 Field Quality Control Samples

Field quality control samples that may be completed during the RD/RA or in subsequent work are discussed in the QAPP and summarized in the following subsections.

5.4.1 Trip Blank

One trip blank will be submitted to the laboratory with each shipment of samples for volatile organic analysis. The analysis of this blank will provide a baseline measurement of any contamination to which the samples may have been exposed during transport. A trip blank is comprised of a sample bottle provided by the laboratory filled with deionized, organic-free water, preserved, handled like a sample, and returned to the laboratory for analysis. Trip blanks will be prepared by the analytical laboratory and will be submitted for both liquid and solid samples.

5.4.2 Equipment Blank

One equipment blank will be collected per sampling episode per sampled medium or at a frequency equal to approximately 5% of the samples collected for each medium, whichever is larger. The analysis of these blanks serves to verify the cleanliness of the sampling equipment. An equipment blank is collected by rinsing decontaminated field equipment with water, transferring the water to a sample bottle, and submitting the sample for analysis. Deionized, organic-free water provided by the laboratory will be used for the field blanks. The equipment blank will be analyzed for the same parameters as the samples associated with that equipment.

5.4.3 Field Duplicates

Approximately 5% of all the samples will be collected in duplicate and submitted for laboratory analysis. Duplicates are two samples collected independently from one sampling location during a single episode of sampling. Duplicates provide information about sample variability.

5.4.4 Matrix Spike/Matrix Spike Duplicates

Matrix spike and matrix spike duplicates (MS/MSDs) are a quality control requirement performed by the laboratory. It is necessary to collect three times the usual required volume for aqueous samples to be analyzed as MS/MSDs. No additional sample volume is necessary for solid samples. At a minimum, additional volume for one sample will be provided to the laboratory for every group of 20 samples collected per medium and matrix.

5.5 Environmental Conditions

Sampling at the Site may be conducted at any time of year, regardless of the weather. Extreme heat or cold will require increased attention to health and safety issues, and may impact the duration of work. Equipment such as Geoprobe® or hollow-stem auger rigs require longer warm-up times in cold weather. Some areas of the Site may be impassable to vehicles and personnel during wet periods. Consideration shall be given to these and other relevant weather impacts before scheduling field work.

5.6 Decontamination Procedures

Sampling equipment decontamination procedures will vary depending on the field task. The various levels of decontamination to be performed between sampling locations for the various types of field activities are described below.

Level 1 (Split-Spoons, Trowels, etc.)

- Wash/scrub with potable water; and
- Potable water rinse.

Level 2 (IP, Water Level Meter and Probes)

- Rinse with laboratory detergent/distilled water solution; and
- Rinse with distilled water.

Level 3 (Sampling Equipment that comes in Direct Contact with the Analytical Sample Media)

- Wash/scrub with laboratory detergent/distilled water solution;
- Distilled water rinse,
- Laboratory-grade methanol rinse (if organic analyses are planned);
- Distilled water rinse;
- Laboratory-grade 10% nitric acid rinse (if metals analyses are planned); and
- Final distilled water rinse.

The waste water generated from the decontamination procedures will be containerized and managed as described in Section 5.7.

5.7 Investigation Derived Waste

Investigation derived waste (IDW) generated from field activities will be containerized in labeled 55-gallon DOT-approved steel drums and staged at a pre-designation location at the Site for characterization and disposal. Information contained on the label will include the drum contents, name, address and telephone number of generator, date(s) the material was placed in the drum, and a BC contact name/telephone number. Wastes will be separated based on type. For example, separate drums will be filled for solid landfill waste, contaminated soil, monitoring well development and purge water, decontamination wastewater,

LNAPL/DNAPL, used personal protective equipment (PPE), and general trash. If a sufficient quantity of general trash is expected, then a dumpster or roll-off might be staged for this material instead of drums.

For liquid wastes, characterization of the drummed IDW will consist of collecting a composite sample from drums of similar contents and sending the sample to the analytical laboratory to be analyzed for the parameters required by the designated waste receiving facility. Characterization sampling will occur as soon as possible following field activities to ensure compliance with all local, state and federal regulations regarding storage of IDW.

Investigation generated wastes will be disposed in accordance with applicable Federal, State, and Local regulations.

FIELD SAMPLING PLAN

6. SAMPLE HANDLING AND CUSTODY

An important aspect of field sampling quality assurance involves proper sample handling and strict chain of custody protocol. Improper sample handling may lead to results that are not representative of the materials sampled. BC will take precautions while handling samples to maintain the integrity of the sample. Such precautions include employing proper sample transfer procedures, use of proper sample containers, use of proper sample preservation techniques, and observing sample holding times.

6.1 General Sampling Protocols

6.1.1 Sample Containers

Table 6-1 describes the sample containers needed for the various potential analytical analyses.

6.2 Chain-of-Custody

The chain-of-custody procedures are initiated in the field following sample collection. The procedures consist of: (1) preparing and attaching a unique sample label to each sample collected, (2) completing the chain-of-custody (COC) record, and (3) preparing and packing the samples for shipment. These procedures are briefly described in the following subsections.

6.2.1 Sample Labels

Field personnel are responsible for uniquely identifying and labeling all samples collected during the field investigation program. All labeling must be completed in indelible/waterproof ink and securely affixed to the sample container.

All sample containers will be affixed with label that will contain the following information:

- Sample identification (see Section 4.1); Depth of sample (if appropriate);
- Analysis/test to be performed;
- An “up” arrow (Shelby tube samples only)
- Preservative (if required);
- Project name and number;
- Date and time of sample collection; and
- Initials of Sampler

6.2.2 Chain-of-Custody Record

The COC record, an example shown in Figure 6-1, will be completed for the geotechnical samples submitted to the laboratory. These forms are maintained as a record of sample collection, transfer, shipment, and receipt by the laboratory. These forms also contain pertinent information concerning sampling location, date, and times, signatures of at least one team member; types of samples collected along with a unique sample identification

number; the number of samples collected and shipped for testing, the requested tests, the project number, and the name of the laboratory to which the samples are being sent.

6.2.3 Transfer of Custody

Samples will be accompanied by COC form during each step of custody, transfer, and shipment. When physical possession of samples is transferred, both the individual relinquishing the samples and the individual receiving them will sign, date, and record the time on the COC form.

6.3 Sample Packaging and Shipment

Following sample collection, all samples will be brought to an onsite location for batching and paperwork checks. Label information is checked to ensure there is no error in sample identification. The samples will be packaged to prevent breakage and/or leakage, and staged awaiting hand delivery to the geotechnical laboratory on a weekly basis.

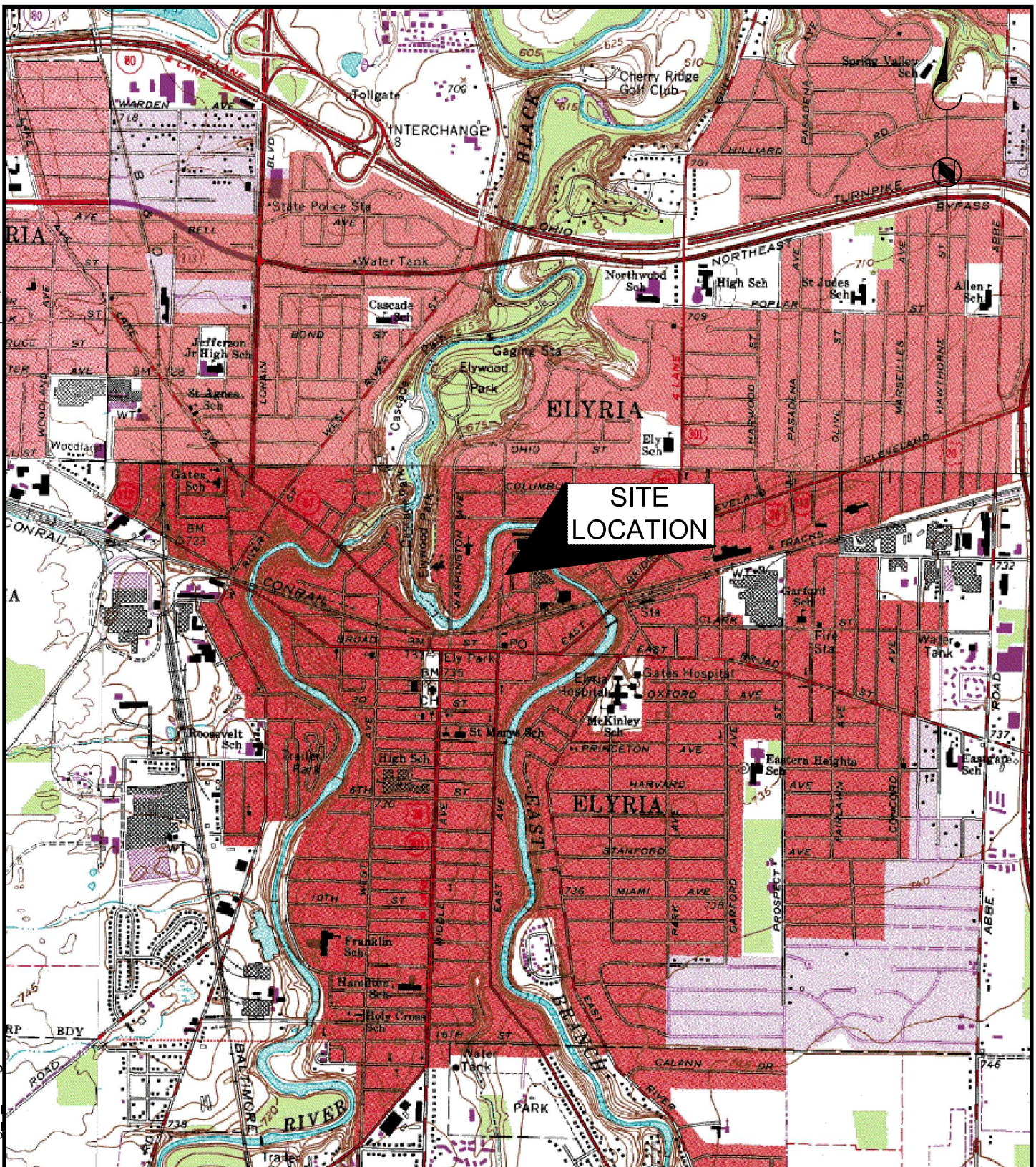
FIELD SAMPLING PLAN

7. REFERENCES

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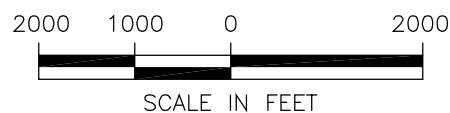
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CHEMICAL RECOVERY SYSTEMS, INC. SITE
ELYRIA OHIO

SOURCE: BASE MAP USGS 7.5 MIN. QUAD., AVON, OH, 1994



SCALE IN FEET



OHIO
QUADRANGLE LOCATION
LATITUDE 41° 22' 15"
LONGITUDE 82° 06' 12"

TABLE 6-1

ANALYTICAL SAMPLE VOLUME AND CONTAINERS

Ford Road Landfill
Elyria, Ohio

Analytical Method	Aqueous Matrix			Aqueous Matrix		
	Sample Container	Preservative	Holding Time	Sample Volume	Preservative	Holding Time
VOCs	2-ounce glass ¹	4° C	14 days	3 X 40-ml glass ²	HCl to pH<2; 4° C	14 days
SVOCs	4-ounce glass ¹	4° C	14 days	2 X 1-liter amber glass ²	4° C	7/40 days ³
Metals	4-ounce glass ¹	4° C	180 days/28 days for Hg	500-ml glass or plastic	HNO ₃ to pH<2; 4° C	180 days/28 days for Hg
PCBs	4-ounce glass ¹	4° C	14 days	2 X 1-liter amber glass ²	4° C	7/40 days ³

Notes:

1 - Wide-mouth glass jar with PTFE-lined lid.

2 - Glass with Teflon®-lined cap.

3 - 7 days till extraction and 40 days till analysis.

ATTACHMENT A - SOPS AND ASTM STANDARDS



STANDARD OPERATING PROCEDURE (SOP)
NO. 1

**MONITORING WELL INSTALLATION AND
DEVELOPMENT**

**Brown and Caldwell
Standard Operating Procedure**

**Groundwater Monitoring Well
Installation and Development**

**Revision 1.0
Revision Date: October 31, 2000**

Prepared/Revised by:	<u>Rebecca Frend</u> Name	<u>October 31, 2000</u> Date
Senior QA Review:	 Name	<u>10/26/01</u> Date
Regional Quality Officer:	 Name	<u>October 26, 2001</u> Date

GROUNDWATER MONITORING WELL INSTALLATION

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1.0 OBJECTIVES

The objective of this standard operating procedure (SOP) is to provide the methods to be used for the installation and development of groundwater monitoring wells and to provide standardized reporting formats for documentation of data. This SOP has been specifically designed with the objective of installing and developing wells for environmental investigations.

2.0 SCOPE AND APPLICABILITY

This procedure is intended for use by Brown and Caldwell for the installation, development, and documentation of monitoring wells that will be used for environmental investigations.

Specific monitoring well design and installation procedures depend on project-specific objectives and subsurface conditions and should be discussed in project-specific planning documents. The following aspects will need to be determined when planning a well installation:

- Borehole drilling method
- Construction materials
- Well depth
- Screen length
- Well construction materials
- Location, thickness, and composition of annular seals
- Well completion and protection requirements.

Groundwater monitoring well installation and development will be performed in accordance with applicable well standards for the area of the investigation, this SOP and the project-specific planning documents. Drilling methods employed to pilot the borehole for monitoring well installation will be dependent on the physical nature of

the subsurface materials (unconsolidated materials and/or consolidated materials) at the site. The drilling contractor shall be a licensed water well driller, in accordance with local and state requirements, and a qualified drilling contractor for the installation of groundwater monitoring wells for environmental investigations.

2.1 Health and Safety

Potential physical and chemical hazards will need to be addressed when planning monitoring well installation. A health and safety plan that addresses known and anticipated field conditions must be prepared prior to field work and be followed during well installation.

3.0 RESPONSIBILITIES

The project manager is responsible for ensuring that the project involving monitoring well installation is properly planned and executed and that the safety of personnel from chemical and physical hazards associated with drilling and well installation is provided for.

The field geologist or engineer is responsible for directly overseeing the construction and installation of the monitoring wells by the driller and to ensure that the project specific well-installation specifications defined in the project-specific planning documents are followed and that pertinent data are recorded on appropriate forms and in the field notebook. Monitoring well construction and boring completion will be conducted under the supervision of an appropriately qualified and registered person as defined by local regulations.

The site safety officer, typically the field geologist or engineer, is responsible for overseeing the health and safety of Brown and Caldwell employees and for stopping work if necessary to fix unsafe conditions observed in the field. If a subcontracted

firm conducts installation and documentation activities, then the firm will designate a site safety officer.

4.0 REQUIRED MATERIALS

Many materials are required for successfully completing the installation and development of monitoring wells. The drilling Subcontractor often supplies much of the material. However, the field personnel should be aware of what is required to conduct the work so they have their own supplies and can provide complete Subcontractor oversight. The following is a general list of materials that are needed for performing the tasks outlined in this SOP.

Geologist

- Hand lens
- Health and Safety supplies (e.g., steel toed boots, gloves, hard hat, etc.)
- Lithologic Logs and Well completion forms
- Logbook
- Logging assistance tools (e.g., grain size charts, color charts)
- Measuring tapes (both long weighted cloth type and small measuring tape, preferably marked in tenths and hundredths of a foot)

Drilling Subcontractor

- Drilling equipment (depends upon the type of drilling, e.g., drill stem, auger, generators, compressors, steam cleaners, etc.)
- Well drilling supplies (drilling mud,
- Decontamination Pad construction supplies
- Well construction supplies (screen, well casing, sand pack, bentonite chips, bentonite, cement mixture, water).

- Health and safety records required for working on site
- Driver's licenses
- Ancillary support vehicles
- General tools

5.0 METHODS

The borehole diameter must be a minimum of four (4) inches greater than the outside diameter of the well screen or riser pipe used to construct the well. This is necessary so that sufficient annular space is available to install filter packs and grout seals. All boreholes will be cleared for shallow obstructions by following the SOP for Utility Clearance.

5.1 Drilling Methods

Several drilling methods are available for use in creating a borehole for well installation. These methods include hollow stem, air rotary, mud rotary, and cable tool, among others. The drilling method selected will be based on the physical properties of the subsurface materials.

5.1.1 Hollow Stem Auger Methods

Hollow stem auger uses continuous flight hollow stem auger with a bit on the bottom to drill and maintain an open borehole. The continuous flight auger drives the drill cuttings to the surface as drilling progresses. The walls of the auger minimize the amount of unconsolidated materials entering into the space inside the casing. Intact soil samples are collected by pounding a sampler ahead of the auger. The well casing, filter pack and seal are installed inside the auger. The auger is removed slightly ahead of backfilling as filter pack and grout are added. Careful recording of the amount of each material used should be recorded in the field logbook.

5.1.2 Mud Rotary Methods

Mud rotary drilling uses drilling fluids to circulate drill cuttings to the surface. Drilling fluid will consist of only uncontaminated air, water or uncontaminated water mixed with bentonite. Powdered bentonite or an approved equivalent will be used as an additive in the drilling fluid. Bentonite will be mixed into the drilling fluid using a mud mixer and a portable mud tank. Drilling fluid density and viscosity will be maintained at appropriate levels for the various lithology encountered and in accordance with material specifications.

A shale-shaker and de-sanding system will be used to maintain the density and viscosity of the drilling fluid. Sand content will be minimized to the degree possible by maintaining no greater than 4 percent sand by mud volume.

If water or other drilling fluids have been introduced into the borehole during drilling or well installation, samples of these fluids should be obtained and analyzed for chemical constituents that may be of interest at the site. In addition, an attempt should be made to recover the quantity of fluid or water introduced by flushing the borehole before well installation and/or by pumping the well during development.

5.1.3 Air Drilling Methods

The following are descriptions of air rotary, “down-the-hole”, and dual-wall reverse circulation air rotary methods. Air rotary uses air as a primary means of transporting drill cuttings to the surface. A large compressor provides filtered air that is piped to the swivel hose connected to the top of the Kelly bushing or drill pipe. The air, forced down the drill pipe, escapes through small ports at the bottom of the drill bit, thereby lifting the cuttings and cooling the bit. The cuttings are blown out the top of the hole and are collected at the surface in a cyclone unit and a

two- to four-yard roll-off container. Injection of a small volume of clean water into the air system controls dust and lowers the temperature of the air so that the swivel is cooled. Air drilling is effective in semi-consolidated or consolidated materials.

A second direct rotary method using air is called the “down-the-hole” or percussion down hole hammer drilling system. A pneumatic drill operated at the end of the drill pipe rapidly strikes the rock while the drill pipe is slowly rotated. The percussive effect is similar to the blows delivered by a cable tool bit. Cuttings are removed continuously by the air used to drive the hammer.

A third direct air rotary method is called the Air Rotary Casing Hammer (ARCH) method is used where an outer steel casing is advanced slightly behind the drill bit. The drill bit reams material in front of the casing and then the casing is advanced with a pneumatic hammer down the hole to prevent hole collapse. Cuttings are collected in a tube system that conveys them into a cyclone at the surface.

Dual-wall reverse circulation air rotary method uses flush-jointed, double wall pipe in which the air moves by reverse circulation. The airflow is contained between the two walls of the dual-wall pipe and only contacts the walls of the borehole near the bit. Dual-wall pipe can be driven into place in loosely consolidated materials by a pile hammer as a drive bit is cutting the formation. Downhole air hammers and tricone bits can also be used to cut the formation. The air lifts the cuttings to the surface through the inner pipe. Dual-wall methods can be applied in consolidated and unconsolidated formations.

5.1.4 Rotosonic Drilling

This section to be added as needed later.

5.2 Borehole logging

Boreholes will be logged using cuttings and samples collected during drilling activities. Soil or rock samples will be collected as described in the SOP for Soil Sampling. Cuttings and soil and rock samples will be described at the frequency presented in the project-specific planning documents following the procedures outlined in SOP for Field Classification and Description of Soil and Rock.

After drilling has been completed, the field geologist/engineer will measure the total open depth of the borehole with a weighted, calibrated tape measure and document the depth. The field geologist will then collaborate with the supervising geologist by reviewing lithologic units encountered, water levels, if any, and other logged information to determine the well construction details.

Boreholes/well locations should be clearly designated in the field notes using notes and a hand sketched layout and should include the following information:

- Measurements of each boring/sample point relative to fixed objects (building, structures, etc),
- Boring/sample location with their identification number noted,
- North arrow or other compass directional indicator, and
- Other essential site features and/or investigation features (underground storage tanks, piping, above ground tanks, etc.).

5.3 MONITORING WELL CONSTRUCTION PROCEDURES

Monitoring wells will be constructed in accordance with state and local agency requirements, and will include at a minimum the following materials:

- Borehole backfill for overdrilled boreholes prior to well installation,
- Well casing and screen

- Filter pack materials
- Well sealing materials (e.g., bentonite pellets, cement, powdered bentonite), and
- Surface seals and materials for well surface completion (e.g., concrete, protective steel casing, steel posts, surface boxes).

A discussion of these materials and how they are used is provided in more detail in the following sections.

5.3.1 Backfilling.

If backfilling the borehole to the appropriate well installation depth is necessary, neat cement, bentonite grout, bentonite pellets or filter pack sand may be used. The backfill material selected for use will depend on site conditions, lithology, and project-specific requirements. Most often the borehole requires complete sealing with lower layers, so neat cement, bentonite grout, or bentonite pellets are used. The setup time should be a minimum of 48 hours for neat cement and 24 hours for bentonite grout and bentonite pellets prior to beginning well construction. Field personnel should remeasure and verify that the bottom of the bore hole is exactly where it should be set before proceeding with well construction. The necessary setup times may be reduced if manufacturer- approved additives are mixed with the grout to accelerate the cure time.

If neat cement or bentonite grout is used, a tremie pipe will be required to place the grout in the bottom of the hole. Grouting the borehole may be difficult to accomplish, if the portion of the borehole to be grouted is significantly lower than the groundwater level. Provisions will be necessary to support the screen and riser pipe to prevent them from sinking into the grout. Care will be taken to frequently measure the total borehole depth when adding grout to the bottom of the hole.

Grout should have thickened to a hardened state before proceeding. The thickness of the grout will be calculated based on depth readings and recorded. If a well has been backfilled too much it may require reaming to clear out the overfilled material.

Depending upon the lithology some distance should be planned between the fill in a borehole and the bottom of the screened interval. Unless this distance would result in a breach confining layer, or the well screen requires setting directly on the impermeable zone due to site requirements, the bottom of the well screen should be set at a maximum of 6 inches above the top of any backfill. The distance between the top of fill and the bottom of the well screen should be filled with a fine sand buffer.

Bentonite pellets should be carefully dropped into the borehole to minimize the risk of pellets sticking to the side of the borehole when dropped through a water column. Pellets are generally easier to place than bentonite chips because pellets do not hydrate as quickly, hence pellets are the preferred method for small backfill jobs where significant confining zones have not been breached.

5.3.2 Well Casing and Screen

The monitoring well will consist of factory-sealed commercially available well screen and casing. Well screens and casing will typically be constructed of polyvinyl chloride (PVC), a type of plastic, but may also be constructed of stainless steel or Teflon depending on subsurface conditions or other project requirements. Stainless steel casing shall meet one of the following standards: American Society For Testing Materials (ASTM) A-53-93A or B, A-589-93, or American Petroleum Institute 5L, March 1982 Edition to conform to the minimum standards given in Table A of that document.

Plastic casing and liners shall meet the requirements of ASTM Standard F480-94 and the National Sanitation Foundation (NSF) International Standard Number 14-1990, Plastic Piping System Components and Related Materials. Evidence of compliance shall be included in the current NSF listing and display of the NSF seal on each section of casing, and marking the casing in accordance with the requirements of ASTM Standard F-480-94. Plastic well casing and liners must be Standard Dimension Ratio (SDR)-rated and conform to the minimum requirements given in Table B of the above-referenced document.

Well screens shall be constructed of non-corrosive and non-reactive material. Well screens shall be permanently joined to the well casing and shall be centered in the borehole. The anticipated length of screen and the reasoning behind choosing the length of screen will be determined when developing the project-specific planning documents. Modification can be made in the field, but will be done in consultation with the PM, or their designee such as the Project Technical Manager or Responsible Geologist.

Screen slot type and size will be dependent on the sand pack material and the aquifer formation material. Casing will be connected by flush-threaded or coupled joints and will be completed with a bottom cap. A collection sump may be installed below the screen and will vary in length depending on lithology and project needs. The collection sump and bottom cap will be connected to the well screen by flush threaded or coupled joints. Plastic casing must have threaded joints and O-ring seals. Solvent, glue, or anti-seize compounds will not be used on the joints. With deep wells (greater than approximately 100 feet below grade), centralizers should be used to keep the well casing plume and straight in the borehole. Centralizers should be placed at approximately 20 foot intervals in the screen interval and 40 foot intervals throughout the blank casing interval.

For water table wells, well screens should be placed such that some of the screened interval is above the water table, and some section is below the water table. This allows for seasonal fluctuations. The amount of split should be determined by the lead responsible geologist and be based upon local conditions.

Casing and screen (well string) must be clean, free of rust, grease, oil or contaminants and be composed of materials that will not affect the quality of the water sample. All casing shall be watertight. The casing shall be centered in the borehole, be free of any obstructions and allow sampling devices to be lowered into the well. The well string shall be hung in the borehole during installation so that the well is sufficiently plumbed and straight after completion.

5.3.3 Filter Pack

Monitoring wells installed in unconsolidated material will be constructed with filter packs. When used, the filter pack will be the only material in contact with the well screen. The filter pack will consist of sand or gravel. The sand or gravel used for filter pack material shall be sized to match the screen slot size and the surrounding lithology to prevent subsurface materials from penetrating through the sand or filter pack, and preventing the sand or filter pack from entering the well. Sizing of the filter pack material is often conducted using sieve analysis and following interpretative procedures outlined in Driscoll (1986). The sand or gravel shall be free of clay, dust, and organic material. Crushed limestone, dolomite, or any material containing clay or any other material that will adversely affect the performance of the monitoring well shall not be used as filter pack. The filter pack will extend a maximum of six (6) inches below the bottom of the screen to two (2) to three (3) feet above the top of screen. The filter pack material may be placed in the well by pouring the sand into the open borehole, or tremied into place depending upon site-specific criteria. However, in all cases, filter pack material should be

added carefully with continuous measurements by the field geologist to prevent bridging of the filter pack material.

Groundwater wells completed into competent bedrock material are often not completed with filter pack material, and can be completed as an open hole over the screened interval. Completion in this manner should be carefully considered and approved by regulatory agencies prior to field mobilization.

The well will be gently bailed and surged with a bailer and surge block after the filter pack has been added to the borehole and before the seal is placed in the annular space. A surge block consists of a rubber or leather and metal plunger attached to a rod or pipe of sufficient length to reach the bottom of the screen. Surging should be maintained for at least five minutes and the entire length of saturated screen will be surged to help settle the filter pack. The top of the filter pack will need to be gauged after surging and additional filter pack material may need to be added if settling has occurred.

Sometimes project specific requirements may identify that a transition sand be emplaced above the main filter pack. This transition sand is usually much smaller grain size than the filter pack, and is emplaced to provide added protection that grout invasion into the filter pack will not occur when deep wells (greater than 200 feet deep) are installed. Transition sands can be emplaced up to 10 or 20 feet above the regular sand pack interval. An alternative to transition sands is to use additional well seal material such as bentonite pellets.

5.3.4 Well Sealing Material

The wells will have an annular space seal that extends from the top of the filter pack to the surface. The annular sealing material above the filter pack will prevent the migration of fluids from the surface and between aquifers. Sealing material will be chemically compatible with anticipated contaminants. Hydrated bentonite chips or pellets are typically used as an annular seal directly above the filter pack. The annular seal should be a minimum of 3 feet thick unless site-specific requirements dictate otherwise. For example, as mentioned above, deep wells may require additional sealant material (10 to 20 feet thick versus 3 feet) between the sand pack and cement ground annular fill above to prevent grout invasion into the filter pack interval. Cement and/or bentonite grout are typically used as annular fill above the seal. Above the sealant material a bentonite grout mixture is often used as an annular fill to complete the well installation to within 2 feet of the surface. Grouting emplacement will occur using a tremie pipe so that the grout fills the annular space from the bottom to the surface without allowing air pockets to form in the filled zone.

5.3.5 Surface Completions

Above Grade or Monument Surface Well Head Completion

With above-grade well completions, the well casing will extend to 1 to 2 feet above the ground surface. A locking cap will be placed at the top of the casing and the cap will be watertight. The section of casing that sticks up above ground will be protected by a steel protective pipe, set at least 2-feet deep into a concrete surface seal. A concrete pad should be constructed around the protective steel pipe. The pad should be square, approximately 1.5-by-1.5 to 2-by 2-feet, sloped slightly away from the well, and the top of the pad should be approximately 4-inches off the ground. Specific client needs may differ from this construction, and such requirements

should be outlined in project specific planning documents. The top of the protective pipe will have a vented lockable cap. Protective steel posts will be installed in areas where the well could be struck by vehicles or heavy equipment. In addition, a “weep” hole should be drilled in the bottom of the protective steel pipe. In areas where freezing may occur, placement of the weep hole is critical; little volume should exist in the protective casing above the weep hole where water could accumulate and freeze thereby damaging the well. A “V” notch or other permanent mark will be placed at the north edge of the top of the well casing that will be used as the reference point for well elevation surveying and water level monitoring.

Ground or Grade Surface Well Head Completion

Monitoring well casing may terminate at the ground surface with a flush mounted traffic-rated road box. Road box installations must use a watertight well cap for the well riser pipe in addition to a watertight road box to prevent surface water from entering the well. The well casing should extend approximately 3 inches above the sealant in the bottom of the well box. The traffic-rated road box and surface concrete completion should meet Class A specifications, which meet a minimum 4000-pound compressive strength. The surface completion should provide positive drainage away from the well box to prevent ponding around the well. In traffic areas and sidewalks, this positive drainage slope away from the box should be minimized to prevent physical hazards. The surface seal around the box should be a minimum of 12 inches around the perimeter of the box. As discussed above a reference mark should be placed on the top of the well casing for well elevation surveying and water level monitoring.

5.3.6 Monitoring Well Location and Surveying

Monitoring wells will be located by parcel coordinates required by local permit requirements. Each well will be surveyed by a licensed surveyor in the state where

the well has been installed and tied to an established state or county benchmark, site conditions permitting. The vertical survey will be accurate to 0.01 foot relative to mean sea level. Both the top of casing and ground surface elevation near the well will be surveyed for vertical control. The “V” notch cut on the north side of each well casing will be used as the surveyor’s reference mark. For horizontal control, each well will be tied to an existing site coordinate system and will be surveyed to a horizontal accuracy of 0.1 foot.

5.4 Well Development

Monitoring well development is necessary to ensure that complete hydraulic connection is made and maintained between the well and the aquifer material surrounding the well screen and filter pack. The appropriate development method will be selected for each project on the basis of the circumstances, objectives, and requirements of that project.

The appropriate development method will be selected for each project based on the lithology, objectives, and requirements of that project. Project-specific planning documents will identify the specific development method to be used. In general, most wells will be developed by using surge block and bailing methods to draw the coarse and/or fine material out of the sand pack. Other development methods that may be used include jetting, airlift, and submersible pump methods. These methods are discussed further below. Jetting is typically not used as a development method for environmental investigations, but is commonly used for water resource monitoring wells or production wells.

Well development should begin no sooner than 48 hours after well installation. However, if drilling muds are used during well installation, well development should occur approximately 24 hours following well installation so that the drilling mud does not set up in the well screen section.

Generally a phased process is used to develop wells, starting with a gentle bailing phase to remove sand, followed by a surging phase, then a pumping phase after the well begins to clear up. The following paragraphs provide more detailed information.

After a well is first installed, and in fact, often before the bentonite pellet seal is set, gentle bailing is used to remove water and sand from the well. The purpose of this technique is used to settle the sand pack. After further well sealant materials have been added and allowed to set for approximately 48 hours, bailing is resumed as part of well development. The purpose of bailing is to remove an fine material that may have accumulated in the well, and start pulling in natural material into the sand pack. Bailing is often conducted until the sand content in the removed water begins to decrease.

After the sand content begins to decrease, surging is conducted. A surge block is used to move sediments from the filter pack into the well casing. A surge block consists of a rubber (or leather) and metal plunger attached to a rod or pipe of sufficient length to reach the bottom of the well. All surge blocks will be constructed of materials that will not introduce contamination into the well. Surge blocks should have some manner of allowing pressure release to prevent casing collapse. The surge block is moved up and down the well screen interval and then removed, followed by a return to bailing to remove any sand brought into the well by the surging action. Care should be taken to not surge too strongly with subsequent casing deformation or collapse; the well screen interval is often the weakest part of a well. Surging should be followed by additional bailing to remove fine materials that may have entered the well during the surging effort.

After surging has been completed and the sand content of the bailed water has decreased, a submersible pump is used to continue well development. The pump

should be moved up and down the well screen interval until the obtained water is relatively clear. Well development will continue until the water in the well clarifies and monitoring parameters such as pH, specific conductivity, and temperature stabilize as defined in the project-specific planning documents. It should be noted that where very fine-grained formations are opposite the screened interval, continued well development until clear water is obtained might be impossible. Decisions regarding when to cease development where silty conditions exist should be made between the field supervisor and PM.

During well development pH, specific conductivity, temperature, and turbidity should be monitored frequently to establish natural conditions and evaluate whether the well has been completely developed. The main criteria for well development is clear water (Nephelometric turbidity units or NTU of less than 5). As mentioned above, clear water can often be impossible to obtain with environmental monitoring wells. A further criteria for completed well development is that the other water quality parameters mentioned above stabilize to within 10 percent between readings over one well volume.

The minimum volume of water purged from the well during development will be approximately a minimum of 3 borehole volumes (wells will typically not reach stabilization of water quality parameters before this condition is achieved and may not have reached stability even after this threshold has been achieved). The above is a general guideline for difficult well development - project-specific planning documents should address project constraints on well development. Development water will be stored in 55-gallon Department of Transportation (DOT) -approved drums and/or baker tanks depending upon the total volume of purge water removed from the newly installed wells.

5.5 Disposal And Decontamination

All drill cuttings and fluids generated during well installation and development will be containerized pending analytical results and determination of disposal options as outlined in the Investigation-Derived Waste Handling SOP unless project-specific requirements unless specify otherwise. Waste containment and disposal will occur in a manner that will not result in contamination of the immediate area or result in a hazard to individuals who may come in contact with these materials.

All drilling and well construction equipment that comes into contact with the borehole will be decontaminated by following the Equipment Decontamination SOP.

6.0 QUALITY ASSURANCE/QUALITY CONTROL

Borehole drilling and well construction details will be documented in detail in the field. Field documentation forms will consist of a lithologic borehole log, a well construction log, and daily field note forms. Examples of these forms are included in Attachment A. Deviations from project-specific planning documents will be documented and explained in daily field notes. The program manager will be contacted to discuss project deviations.

Field quality control can be maintained through 1) making sure employees are properly trained to conduct the work being implemented, and 2) performing routine field audits to evaluate how well employees are following procedures. These two aspects of QA/QC are detailed in the Quality Assurance Program documentation.

7.0 RECORDS

Field notes and logs will be submitted to the Project Manager or designate immediately following the field event for checking and revision purposes. The Project Manager or designate shall review and transmit the completed forms for incorporation into the project file.

8.0 REFERENCES

- California Department of Water Resources, 1981, State of California Water Well Standards, Bulletin 74-81.
- California Department of Water Resources, 1990, State of California Water Well Standards (modified), Bulletin 74-90.
- Driscoll, F.G., 1986, Groundwater and Wells, Second Edition, Johnson Filtration Systems, Inc., St. Paul, MN.
- United States Environmental Protection Agency, 1989, Handbook for Suggested Practices for the Design and Installation of Monitoring Wells, EPA 600/4-89/034, Reprinted by the National Ground Water Association.

9.0 ATTACHMENTS

Attachment A – Well Construction and Lithologic Log Form

ATTACHMENT A

WELL CONSTRUCTION AND LITHOLOGIC LOG FORM

BOREHOLE/WELL LOG

P:\Special\DACW05-97-D-0035A E\Field Activities\SOP - Monitor Well Installation and Development - Attachment A-boring log form.xls

STANDARD OPERATING PROCEDURE (SOP)



NO. 2

MONITORING WELL SAMPLING

**Brown and Caldwell
Standard Operating Procedure**

Groundwater Sample Collection

**Revision 1.1
Revision Date: October 9, 2001**

Prepared/Revised by:	<u>Wendy Linck</u>	<u>October 9, 2001</u>
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GROUNDWATER SAMPLE COLLECTION

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1.0 OBJECTIVES

The primary objective of this standard operating procedure (SOP) is to establish a uniform method for the collection of representative groundwater samples from monitoring wells, and to reduce the potential variability associated with purging and sampling.

2.0 SCOPE AND APPLICABILITY

This SOP will be used to support groundwater monitoring programs and conducting the field groundwater sampling activities. Groundwater sampling involves two primary operations, purging stagnant water from a well followed by the collection of a sample from the same well. Groundwater sampling variables can be significantly controlled through the appropriate selection and use of purging and sampling equipment, and through the use of procedures that are described in this SOP.

3.0 REQUIRED MATERIALS

Materials required for conducting groundwater sampling are variable depending upon the method chosen to conduct the sampling. Therefore the listing of materials will be separated into two parts in this SOP. This section will present materials that are general in applicability – things that should be included regardless of purge or sampling method. In Section 5, where specific methods and approaches are discussed, additional materials will be listed. General materials that should be considered regardless of method are as follows:

- Health and safety records
- Personal protection equipment (as required by the Site Safety Plan)
- Health and safety monitoring equipment (e.g., PID)

- Well Completion Forms and Data from previous sampling efforts (if available)
- Water level indicator
- Decontamination supplies (5 gallon buckets, decontamination fluids, squirt bottles)
- Water quality monitoring equipment
- Purge pumps and control boxes
- Generator
- Twine
- Permanent marking pens
- Notebook
- Calculator
- Measuring tape
- IDW containers and labels
- Garbage bags
- Drinking water
- Phone, Camera
- Shipping labels and Chain of Custody records
- Coolers
- Ice
- Filters (0.45 μm), if appropriate
- Tubing

Checklists are included in the Readiness Review SOP for help in gathering and monitoring the equipment necessary to conduct groundwater purging and sampling

4.0 RESPONSIBILITIES

The Project Manager, or designee, will have the responsibility to oversee and ensure that groundwater purging and sampling procedures are implemented in accordance this SOP and any project- or site-specific planning documents.

The field personnel will be responsible for the understanding and implementation of this SOP during groundwater sampling activities, as well as, obtaining the appropriate field logbooks, forms and records necessary to complete the field activities.

5.0 METHODS

5.1 General Considerations

Groundwater sampling involves two primary operations. These include the purging of stagnant water from the well followed by the collection of a sample. Groundwater sampling variables can be significantly controlled through the appropriate selection and use of purging and sampling equipment, and through the use of procedures that are described below.

Good communication is essential to the ultimate success of a groundwater sampling project. This includes communication within the project team, as well as communication with the client and analytical laboratory, when establishing project objectives.

Good communication with the project team, laboratory, client, and, if appropriate, regulatory agencies, includes complete project specific planning documents such as field sampling plans, quality assurance plans, and scope of work documents for subcontracted laboratories. Plans should include detailed information with respect to site-specific requirements, with reference to SOPs wherever possible, and risk criteria that will be used to assess the data. The quality assurance plan and laboratory scope of work (of which the quality assurance plan can be part) should contain detailed information regarding what is expected from the laboratory regarding the methods to be used, quality assurance measures and calibrating corrective measures, and deliverables (especially electronic deliverable formats). A

detailed quality assurance plan is even more important in light of EPA's Performances Based Measurement Standard (PBMS) initiative.

In addition to good communication, the project plans should consider equipment decontamination, sampling equipment, sampling sequence, and field quality assurance/quality control (QA/QC) samples. These are described in the following sections.

5.1.1 Equipment Decontamination

Equipment that will be in contact with the sample must be decontaminated prior to each use. This is necessary to minimize inadvertent contamination of the sample. Specific methods for equipment cleaning are dependent upon a number of factors including the sample media, analytical parameters, the purpose of the investigation, the equipment to be cleaned, and the specific regulatory guidelines that may apply.

Equipment decontamination procedures are described in the Equipment Decontamination SOP. Any site specific decontamination procedures can be specified in the field sampling plan for each project.

5.1.2 Dedicated and Disposable Equipment

Use of dedicated and new, disposable purging and sampling equipment are preferable to decontamination of reusable sampling equipment. Dedicated equipment, and use of new, disposable equipment, can virtually eliminate cross-contamination between samples caused by incomplete decontamination. Dedicated equipment can also increase sampling efficiency through the elimination of the need to decontaminate equipment for successive sampling. Furthermore, dedicated equipment can also help to reduce the physical handling of the equipment that can cause sample contamination through contact with potentially contaminated

surfaces. New, disposable equipment may need to be decontaminated before use. Review project-specific planning documents regarding decontamination of disposable equipment.

5.1.3 Sequence of Sampling

The groundwater sampling operation should always be conducted in a sequence that proceeds from wells containing the lowest concentrations to wells containing the highest concentrations. Sampling in this order will further minimize the likelihood of sample cross-contamination that can be caused through improper handling or equipment cleaning. This type of sampling sequence should be used even for programs in which equipment is dedicated to minimize the cross-contamination that could result from exposure to contaminated garments or other equipment. If water quality is not known, the wells upgradient of a suspected source area should be sampled first, followed by the wells furthest away and cross-gradient or downgradient.

Sampling sequence also applies to the order that different analytes are collected. Typically these analytes that are volatile are collected first, followed by those that are sensitive to oxidation.

5.1.4 Field QA/QC Samples

Additional samples should be collected for the specific purpose of documenting the Quality Assurance/Quality Control (QA/QC) of the field sampling procedures. Field QA/QC samples provide technically and legally defensible data regarding the reproducibility and overall quality of the groundwater sample. Descriptions of the type and frequency of QA/QC sampling should be specified in the project-specific planning documents. Field QA/QC samples include field blanks, equipment blanks, trip blanks, and blind duplicates. These samples are collected in addition to the

laboratory QA/QC samples which may include method blanks, matrix spikes and matrix spike duplicate samples.

5.2 PURGING AND SAMPLING PROCEDURES

This section provides a description of the procedures to be used for groundwater sampling. These procedures include planning, preparatory office activities, preparatory field activities, well purging, well sampling, and post sampling activities. These activities are listed on Attachment A and are described in detail in the following sections. Many of these steps have record keeping components which are discussed in detail in Section 5.4.

5.2.1 Planning

The planning phase should include the selection of specific field methods, including the well purging strategy and planning for the proper disposal of the purge water. The sampling program should be discussed in project-specific planning documents.

Good communication with the analytical laboratory is essential to the success of a groundwater sampling project. The analytical requirements must be well defined and clearly communicated, prior to conducting the field work. Written communication is encouraged, in particular to document requirements for specific analytical methods, low detection limits, and other special needs. Written communication should include a detailed scope of work that includes the quality assurance plan for the project. These plans should specifically identify detection limits, with particular emphasis placed on how these limits relate to regulatory criteria or risk based criteria that have been developed for the project.

Purging and Sampling Equipment Selection

Some of the factors that should be considered in the selection of purging and sampling devices include:

- Well yield
- Depth to water
- Well diameter and depth
- Required material of construction
- Analytical parameters
- Regulatory requirements
- Cost

Attachment B presents a summary of purging equipment. Attachment C summarizes well sampling equipment. Attachment D presents a matrix indicating suitability of sampling and purging equipment for specific applications.

Purging Strategies

The strategy that will be employed for well purging should be determined prior to sampling and presented in project-specific planning documents. Several different strategies are commonly used in order to assess the completeness of well purging. The most common purging strategies are listed below.

- Purging is continued until stabilization of certain indicator parameters is observed in successive measurements over a specified time or volume. The most commonly used indicator parameters include pH, specific conductivity, turbidity, temperature, oxidation/reduction potential (ORP), and dissolved oxygen (DO).
- Purging 3 to 5 well volumes of water from the well.

- Purging low yield wells until the water level reaches the top of the well screen, and then allowing the well to partially recover. After partial recovery, the well is re-purged to the top of the well screen and allowing the well to partially recover a second time. It is recognized, however, that it may not be possible to avoid dewatering the well screen in many shallow wells.
- Very low yield wells are purged until dryness and allowing the well to partially recover (often 12 to 24 hours).
- Low or no-flow purging strategies. Generally, well is pumped at rates (<0.5 gallons per minute) that do not induce drawdown and ostensibly mirror flow rates in the aquifer. These are gaining acceptance in many areas because such techniques reduce generated wastes. Often regulatory agencies will require a comparison study before acceptance but these can be valuable when long term monitoring programs will be implemented.

Implementation of these strategies is discussed in more detail in Section 5.2.

Purge Water Disposal

The methods and responsibility for collection, containerization, treatment and disposal of purge water should be determined prior to initiation of any sampling project. Much of how to handle purge water is discussed in the SOP for Investigation Derived Waste. However, additional considerations for groundwater purging and sampling are included below.

Collection and contamination is often accomplished through use of 55 gallon drums, mobile storage tanks, or through use of vacuum trucks which can directly transport off site to a treatment facility or to larger storage tanks on site. If specifically allowed by the responsible agency, purge water may be reapplied to the ground surface. Treatment of purge water may be accomplished on site at facilities that

have wastewater treatment plants, or by using a mobile treatment unit. Responsibility for off-site disposal of containerized purge water must be determined prior to conducting the work.

5.2.2 Preparatory Office Activities

Equipment and containers should be organized in the office prior to embarking on a field sampling project to the extent practicable. The time spent in the field should be spent on sample collection, making field measurements and recording data.

Prepare Sampling and Purging Equipment

The purging and sample collection equipment and all required hardware should be obtained, organized and decontaminated prior to the initiation of the field sampling program. To accommodate waste generated during decontamination, these activities may be completed at the site prior to sampling.

Sample Containers and Preservatives

The appropriate sample containers and associated preservatives must be obtained. The containers and preservatives are normally, but not always, supplied by the laboratory that will be responsible for the analyses. Sample containers should be organized and inventoried several days prior to initiation of the sampling program in order to provide sufficient time to rectify any problems, should they occur. Whenever possible, pre-printed sample labels should be created prior to mobilization, if possible.

Initiation of Field Data Records

Field data sheets should be initiated prior to the start of sampling. Examples of initial data to be recorded include site and sampling location identification, well depth and construction, and purging and sampling collection methods. Additional discussion regarding field records is presented in Section 5.4. Example field data sheets are provided in Attachments E and F. These sheets can be combined in a bound field notebook as well. See SOPs on Sampling Handling, Sample Preservation, and Field Notes and Documentation regarding the requirements for storage/preservation and use of field records, respectively.

5.2.3 Preparatory Field Activities

The following procedures should be conducted in the field prior to well purging and sampling.

Well Maintenance Check

A well maintenance check should be performed that includes a visual inspection of the condition of the protective casing and surface seal. In addition, the well should be inspected for other signs of damage or unauthorized entry. Any problems should be documented.

It is recommended that the bottom of the well not be sounded each time the well is sampled. Routine sounding of the well can increase the risk of inadvertent well contamination because it is difficult to adequately decontaminate the tapes used for this purpose. Well depths obtained from well completion records are generally adequate for the purpose of the determination of well volume. Generally, the only reason to sound well depth is if a need to verify the depth arises, or if you suspect that sediment/soil has collected in the bottom of the well.

Preparation of Well Area

A suitable work area should be established around the perimeter of the well. Sampling equipment should be placed on a clean surface such that it will not become inadvertently contaminated. This work area can be prepared by placing new polyethylene (PE) sheeting on the ground around the well, taking care not to step on it. Alternatives also include the placement of a clean PE-lined trash can, a clean PE or aluminum covered table, or similar, adjacent to the well. Remember – a clean work area leaves a much more favorable impression than a dirty work area.

Water Level Measurements

The depth to water should be measured prior to initiation of all sampling activities. The water level measurements should be made following the SOP for Groundwater Level and NAPL Measurements in Monitoring Wells.

Non-Aqueous Phase Liquid (NAPL) Determination

If their presence is suspected, each well should be evaluated for the presence of light or dense non-aqueous phase liquids (LNAPLs or DNAPLs) prior to well purging. The NAPL measurements should be made following the SOP for Groundwater Level and NAPL Measurements in Monitoring Wells.

Calculation of Well Purge Volume

The volume of water standing in the well should be calculated through the application of the depth to water data, the known well depth, and the well diameter using the constants presented below. Well depth information obtained from the well

completion records are generally sufficiently precise for the purpose of well volume calculations that would be used for subsequent purging determinations.

The following conversions allow quick calculation of well casing volumes:

<u>Well Casing Diameter</u> <u>(inches)</u>	<u>Gallons per foot of water</u>
1.0	0.041
2.0	0.163
3.0	0.367
4.0	0.653
6.0	1.469

Alternatively, the well casing volume may be calculated using the formula $V = CF \cdot d^2 h$, where

V = volume of water (gallons)

d = diameter of well (inches)

h = height of water column (feet)

CF = conversion factor (0.0408) that includes conversion of cubic feet to gallons, inches to feet, and diameter to radius.

In some states the volume of the entire well (not just the well casing, but entire borehole) is required when determining well volume. Check local state requirements to determine which method of well volume calculation applies to your site. This volume can be calculated in a manner similar to above with the following formula:

$$V = 0.0408 d^2 h + 0.0408 (D^2 - d^2) h$$

where

V = volume of water in well (gallons)

D = diameter of borehole (inches)

d = diameter of well casing (inches)

h = height of water column (feet)

\emptyset = porosity of sand pack (often approximated at 0.30)

Which of the above methods should be used should be discussed or defined in the project-specific planning documents.

5.2.4 Well Purging

Monitoring wells must be purged prior to the collection of aqueous phase samples. Specific instructions for the use of purging equipment are presented in Section 4.6.

The placement of a device (in most cases a pump) that will be used for well purging is critical in order to ensure a complete exchange of the entire water column. The intake of a device used for purging should be placed as high in the water column as is possible under pumping conditions. Optimum placement is to have the pump at the top of the water column. This is done so that purging will draw water from the formation into the screened area of the well, and up through the casing, so that the entire static water column can be removed.

If the monitoring well is a slow recharging well, then the pump should be placed near the surface and slowly lowered at a rate similar to groundwater withdrawal. As an alternative approach the pump could be set at no more than three to five feet below the water surface. If the recovery rate of the well is faster than the pump rate and no observable drawdown occurs, the pump can be raised until the intake is within one foot of the top of the water column for the duration of purging. If the pump rate exceeds the well recovery rate, the pump will have to be lowered as needed based upon the amount of drawdown.

Upon completion of purging, the device should continue to be operated as it is slowly withdrawn from the well to purge any water that remains above the pump intake. One should be very careful not to keep the pump on too long after removal, because

a pump can easily burn up without groundwater to cool it. It is recommended that pumps be fitted with backflow prevention valves so that purged water in the discharge tubing does not flow back into the well. Under no circumstances should the pump intake simply be placed at the bottom of the well without first making an effort to evaluate the pumping characteristics of the particular well.

Standard Purging Approach

Initially, groundwater withdrawal should occur no more than three to five feet below the water surface. If the recovery rate of the well is faster than the pump rate and no observable drawdown occurs, the pump should be raised until the intake is within one foot of the top of the water column for the duration of purging. If the pump rate exceeds the well recovery rate, the pump will have to be lowered as needed based upon the amount of drawdown.

An adequate purge is normally achieved when three to five times the volume of standing water in the well has been removed. After three well volumes have been removed, if the chemical parameters have not stabilized according to the criteria given below, additional well volumes may be removed. If the parameters have not stabilized within five volumes, it is at the discretion of the project manager whether or not to collect a sample or to continue purging.

Considering groundwater chemistry, an adequate purge is achieved when the pH, specific conductance, and temperature of the groundwater have stabilized and the turbidity has either stabilized or is below 10 Nephelometric Turbidity Units (NTUs). In very silty formations, the turbidity stabilization criteria given above may be impossible to reach and should be disregarded. Other parameters such as salinity, dissolved oxygen, and oxidation reduction potential also may be important criteria for stabilization, especially under low flow purging. Stabilization occurs when parameter measurements are within 10 percent between two readings spaced

approximately one well volume apart, or under low flow purging, between two readings determined in project planning documents. A water meter quality fitted with flow through cell, which allows continuous monitoring of the above parameters is recommended for these measurements.

Attempts should be made to avoid purging wells to dryness, as previously described. However, even with slow purge rates, a well may be purged dry. In those cases, this constitutes an adequate purge and the well can be sampled when recovery is sufficient (enough volume to fill the sample containers). Recovery criteria are often cited as 80 percent of the original well column height.

Low Stress or Low Flow Groundwater Purging

Sometimes it is desirable to collect representative samples while exerting minimum stress on the water-bearing formation. Typically this is accomplished by limiting the flow rate during purging to the range of 100 to 500 ml/min (0.025 to 0.13 gallons/min). For this procedure, the goal is to induce a steady flow rate while minimizing the drawdown.

It is important to insert the sampling equipment carefully, so as to prevent the re-suspension of silt and clay particles in the well. In order to minimize turbidity, it is preferable to use dedicated equipment, or to allow sufficient time after the installation of non-dedicated equipment to allow soil particles to re-settle before purging and sampling. Sufficient time for settling should be verified by turbidity measurements.

Initially, the purge flow rate should start at approximately 200 ml/min (0.053 gallons/min), and water level should be frequently monitored. Flow rate should be adjusted so that drawdown will not exceed 0.3 ft, or approximately 2 percent of the saturated thickness of low permeability formations, whichever is greater.

Indicator parameters which should be monitored for low stress groundwater purging include turbidity, specific conductance, temperature, pH, ORP, and DO. In-line analyzers and continuous readout displays are recommended, so that the sample is not exposed to air prior to measurement. The well is considered stabilized when three consecutive readings vary no more than 10% or are below 10 NTUs for turbidity, 3% for specific conductance, 0.1 SU for pH, 10 mV for ORP, and 10% for DO. Measurement of the indicator parameters should continue every three to five minutes until these measurements indicate stability in water quality. If these parameters have not stabilized after about an hour, the well should be purged until a minimum of three well volumes have been removed.

5.2.5 Groundwater Sampling

It is important that wells be sampled as soon as possible after purging. If adequate volume is available, the well should be sampled immediately as long as the well has recovered to 80 percent of the original water column height. If not, sampling should occur as soon as the well has recovered sufficiently to provide adequate volume. Specific instructions for the use of sampling equipment are presented in Section 5.2.6.

Standard Sampling Approach

As with purging equipment, there are a number of considerations in the selection of sample collection equipment. Furthermore, it is common to use a different device for sample collection than for purging. An example would be to purge with the use of submersible pump and to collect the sample with the use of a disposable bailer. A summary of well sampling equipment is provided in Attachment B.

As discussed previously, consideration should be given to the order in which sample containers are to be filled for various parameter groups. The order should be determined on the basis of parameter sensitivity to volatilization, pH change, or oxidation, and the priority for analytical data in cases where the water volume in the well is less than what is required for analysis. In general, volatile organic compounds are the most sensitive constituents to volatilization so the sample for these parameters should be containerized immediately. Likewise, pH change occurs rapidly in samples that are in contact with air, so pH measurements and the containerization of pH sensitive parameters, such as anions (e.g., nitrate, sulfate), or metals, (e.g., ferrous iron or Fe^{2+}), should also be implemented expeditiously.

Low Stress Groundwater Sampling

Sometimes it is desirable to collect representative samples while exerting minimum stress on the water-bearing formation. Typically this is accomplished by limiting the flow rate during sampling to the range of 100 to 250 ml/min (0.025 to 0.065 gallons/min). Sampling flow rate should not exceed the purge flow rate for which water quality indicator parameters stabilized. Sampling equipment must be the same equipment that was used for purging, and should not be moved between purging and sampling activities.

5.2.6 Equipment Instructions

This section provides specific instructions for the installation and use of various devices for both well purging and groundwater sample collection, and includes the following equipment:

- Bailer
- Bladder pump
- Small diameter (2-inch) electric submersible pump

- Large diameter (4-inch) electric submersible pump
- Compressed gas-driven piston pump
- Gasoline powered centrifugal pump
- Peristaltic suction pump
- Inertial lift pump.

It is recognized that a combination of the procedures may be employed. An example would be the use of a small diameter electric submersible pump for purging and a bailer for sample collection. The specific methods to be used for purging and sampling a well should be outlined in the project-specific planning documents.

Bailer

A bailer is one of the simplest groundwater sampling devices. The same bailer can be used for both purging and sample collection. Bailers consist of a rigid tube equipped with a bottom and/or top check valve that is lowered into the well on a flexible cord.

Required Equipment:

- Bailer of appropriate size and material
- New bailer cord of appropriate material
- New disposable gloves of appropriate material
- Clean trash can and supply of trash can liners, or new plastic sheeting
- Five gallon pail, graduated in minimum one gallon increments
- Bottom emptying device (optional)
- Water quality monitoring equipment

Purging Instructions:

- Determine the volume of water to be purged, as described previously.
- Place new polyethylene (PE) sheet on suitable surface adjacent to well, taking care not to step on the PE sheet.
- Don a new pair of gloves. Decontaminate equipment as outlined in decontamination SOP
- Attach a cord to the bailer.
- Lower the bailer into the well until it is completely submerged. The bailer should be lowered slowly so that it does not cause a splash that could aerate the water column.
- Pull the bailer out of the well while placing the cord on the PE sheet or in a PE-lined bucket. An alternate method is to wind the bailer cord between the hands. Care should be taken to prevent the bailer or the cord from contacting any surface other than the interior of the well or the plastic liner.
- Empty the bailer into the pail.
- Repeat the operation until the necessary volume of water has been purged from the well.
- Monitor indicator parameters as discussed previously.

Sampling Instructions:

- Prepare the well area and lower the bailer into the well following the method described previously for purging.
- Allow the bailer to fill slowly and then gently retrieve the bailer from the well while avoiding contact with the sides of the well. Care should be taken to prevent the bailer or the line from contacting any surface other than the interior of the well or the PE sheet or PE-lined bucket.
- Fill the sample containers slowly. The use of a bottom emptying device is preferred in that sample aeration and sample volume loss are minimized.

- Bottles should be filled in order of sensitivity to volatilization and oxidation as discussed in Section 5.1.3 or as outlined in project-specific planning documents. Care should be taken to ensure that no head space remains in the volatile organic vials. Certain other parameters may also require minimizing headspace (e.g., reduced or ferrous iron).
- Filtered samples can be obtained by filling a non-preserved sample receptacle, and then transferring the liquid through an in-line filter (typically a 0.45 μm disposable filter) into a preserved sample receptacle using a peristaltic pump. Other gravity feed filters also are available.

Bladder Pump

A bladder pump is one of the easiest devices to operate for the purpose of purging and sample collection. The bladder pump is often dedicated to the well and can be used in conjunction with an inflatable packer in order to minimize the purge volume necessary to accomplish effective purging.

Required Equipment:

- Bladder pump
- Tubing of appropriate type and length
- Bladder pump controller
- Compressed air source
- New disposable gloves of appropriate material
- New plastic sheeting
- Five gallon pail, graduated in minimum one gallon increments
- Water quality monitoring equipment (preferably a flow through cell).
-

Installation Instructions (initial installation or non-dedicated use):

- Place new polyethylene (PE) sheet on suitable surface adjacent to well, taking care not to step on the PE sheet.
- Don a new pair of gloves.
- Assemble the pump and tubing and lower into the well being careful not to contact any surface other than the interior of the well or the plastic sheeting.
- Decontaminate equipment and pump (if not dedicated) as outlined in decontamination SOP
- Install the air inlet and water discharge fittings on top of the well (for a dedicated installation).

Purging Instructions:

- Refuel the gasoline-powered compressor, if used, at a location that is remote from the well, being very careful not to spill any fuel on equipment or clothing that will be used at the well site.
- Place the gasoline-powered compressor as far from the well as possible in a down-wind direction to eliminate potential exhaust impact to sampling.
- Connect the compressed air source and pump controller to the pump as per manufacturer's instructions.
- Don a new pair of gloves after handling the gasoline-powered compressor.
- Determine the volume of water to be purged, as described previously.
- Start the pump by opening the regulator on the controller, which allows compressed air to flow into the system.
- The controller should be adjusted to maximize the flow rate while minimizing the rapid "jolting" of the tubing as water is drawn into pump.
- Direct the pump discharge to the five gallon pail and determine the pumping rate.
- Continue pumping until the necessary volume of water has been purged from the well.

- Monitor indicator parameters as discussed previously.

Sampling Instructions:

- Allow the well to recharge after completion of purging, if necessary.
- Resume pumping after adjusting the regulator to the minimum pressure that will still allow water to be pumped to the surface.
- Collect the samples by pumping directly into each of the required containers.
- Bottles should be filled in order of sensitivity to volatilization and oxidation as discussed in Section 5.1.3 or as outlined in project-specific planning documents. Care should be taken to ensure that no head space remains in the volatile organic vials. Certain other parameters may also require minimizing headspace (e.g., reduced or ferrous iron).
- Filtered samples can easily be obtained by installing an in-line, 0.45 µm disposable cartridge filter directly onto the pump discharge.

Small Diameter (2") Electric Submersible Pump

A small-diameter electric submersible pump (Grundfos Redi-Flo2 or equivalent) can be operated with a wide variety of pumping rates such that it is very versatile for both well purging and sample collection. This type of pump can be used in either a dedicated or non-dedicated mode. Collecting groundwater samples from these pumps is only appropriate if approved project-specific planning documents specifically include this technique for collecting samples.

Required Equipment:

- Small diameter electric submersible pump
- Pump shroud (when used in a six-inch or larger well to minimize turbulence, to keep motor cool)
- Teflon[®] jacketed power cable on a plastic reel

- Tubing of appropriate type and length
- Check valve (optional)
- Electric pump controller with appropriate power plug
- 230 volt, single phase, electric power source, >10 amps
- Tool kit including basic tools, tubing cutters, extra tubing connector bracket, electrical connectors, wire ties, etc.
- Ground fault interrupter (GFI)
- New disposable gloves of appropriate material
- New PE sheeting
- Five gallon pail, graduated in minimum one gallon increments
- Water quality monitoring equipment (preferably a flow through cell).

Installation Instructions:

- Place new polyethylene (PE) sheet on suitable surface adjacent to well, taking care not to step on the PE sheet.
- Don a new pair of gloves.
- Assemble the pump, tubing, optional check valve, and electric power cables.
- Decontaminate equipment and pump (if not dedicated) as outlined in decontamination SOP.
- Prime pump with deionized water by inverting the pump and removing fill cap.
- Lower pump slowly into the well, being careful not to contact any surface other than the interior of the well or the plastic sheeting. When lowering the pump be particularly sensitive to areas that suggest drag or problems in the well where the pump could get stuck. If a problem exists do not continue, but discuss ways to investigate with PM or senior technical personnel.
- Place the pump intake as discussed in Section 5.4.2. Monitor the pump discharge and well hydraulics as discussed previously.

Purging Instructions:

- Refuel the electric generator at a location that is remote from the well, being very careful not to spill any fuel on equipment or clothing that will be used at the well site.
- Place the gasoline-powered compressor as far from the well as possible in a down-wind direction to eliminate potential exhaust impact to sampling.
- Don a new pair of gloves after handling the generator.
- Connect electric power, GFI, and pump controller to the pump.
- Determine the volume of water to be purged, as described previously.
- Start the pump.
- Direct the pump discharge to the five gallon pail and determine the pumping rate.
- Continue pumping until the necessary volume of water has been purged from the well.
- If the pump intake has been placed deeply down into the water column for some reason, slowly withdraw the pump upward through the water column while it is still running to purge all water standing above the pump unless the pump will be used for sample collection.
- Shut off the pump rapidly whenever the pump stops pumping water.
- Monitor indicator parameters as discussed previously.

Sampling Instructions:

- Allow the well to recharge after completion of purging, if necessary.
- Resume pumping and adjust the pumping rate to the slowest possible rate.
- Collect the samples by pumping directly into each of the required containers.
- Bottles should be filled in order of sensitivity to volatilization and oxidation as discussed in Section 5.1.3 or as outlined in project-specific planning documents. Care should be taken to ensure that no head space remains in

the volatile organic vials. Certain other parameters may also require minimizing headspace (e.g., reduced or ferrous iron).

- Filtered samples can easily be obtained by installing an in-line, 0.45 µm disposable cartridge filter directly onto the pump discharge.

Large Diameter (4") Electric Submersible Pump

A large-diameter electric submersible pump is most frequently used for purging large-diameter wells that cannot be efficiently purged using other methods. Large-diameter pumps can also be used for sample collection for parameters that are not particularly pH or pressure sensitive. This type of pump is usually not dedicated. Collecting groundwater samples from these pumps is only appropriate if approved project-specific planning documents specifically include this technique for collecting samples.

Required Equipment:

- Large-diameter, stainless steel electric submersible pump
- [Optional] Check valve, install internally within the pump or externally between the pump and the tubing
- Electric power cable on a plastic reel (Teflon[®] jacketed cable is preferred)
- Stainless steel or polypropylene support line
- 1/2" to 1" PE Tubing of appropriate length
- Flow control valve
- 120 or 240 volt electric power source (as appropriate)
- Ground fault interrupter (GFI)
- Tool kit including assorted basic tools, tubing cutters, wire cutters, hose clamps, waterproof connectors, wire ties, hose fittings, assorted pipe nipples and adapters, etc.
- New disposable gloves of appropriate material
- New plastic sheeting

- Five gallon pail, graduated in minimum one gallon increments or flow meter
- Bleeder tee (if the submersible pump is used for sample collection). This consists of a tee with a large diameter, valved pump discharge port and a Water quality monitoring equipment.
- small diameter, valved port equipped with a sample weephole.
- Water quality monitoring equipment (preferably a flow through cell).

Installation Instructions:

- Place new polyethylene (PE) sheet on suitable surface adjacent to well, taking care not to step on the PE sheet.
- Don a new pair of gloves.
- Decontaminate equipment and pump (if not dedicated) as outlined in decontamination SOP.
- Assemble the pump, tubing, flow control valve, electric power cables and support line and lower into well being careful not to contact any surface other than the interior of the well or the PE sheeting.
- The tubing, electrical power cable and support line should be fastened together at 15 to 20 foot intervals with the use of nylon wire ties (not with electrical tape) taking care to leave adequate slack in the electric power cable.
- The use of a check valve is recommended to prevent rapid backflow of water from the tubing after the pump is shut off. It is recognized, however, that the use of a check valve makes it more difficult to pull the pump from the well due to the added weight of the water in the tubing and can increase the chance of "sand locking" occurring in the pump.
- Lower pump slowly into the well, being careful not to contact any surface other than the interior of the well or the plastic sheeting. When lowering the pump be particularly sensitive to areas that suggest drag or problems in the well where the pump could get stuck. If a problem exists do not

continue, but discuss ways to investigate with PM or senior technical personnel.

- Place the pump intake as discussed in Section 5.4.2. Monitor the pump discharge and well hydraulics as discussed previously.

Purging Instructions:

- Refuel the electric generator at a location that is remote from the well, being very careful not to spill any fuel on equipment or clothing that will be used at the well site.
- Place the gasoline-powered compressor as far from the well as possible in a down-wind direction to eliminate potential exhaust impact to sampling.
- Don a new pair of gloves after handling the generator.
- Connect electric power and GFI to the pump.
- Determine the volume of water to be purged, as described previously.
- Start the pump.
- Determine the pumping rate either by directing the pump discharge to the five gallon pail or with the use of a flow meter.
- Adjust pumping rate to match the yield of the well.
- Continue pumping until the necessary volume of water has been purged from the well.
- If the pump intake has been placed deeply down into the water column for some reason, slowly withdraw the pump upward through the water column while it is still running to purge all water standing above the pump.
- Shut off the pump immediately whenever the pump stops pumping water.
- Dispose of the tubing and support line after use.
- Monitor indicator parameters as discussed previously.

Sampling Instructions:

- Allow the well to recharge after completion of purging, if necessary.
- Resume pumping and adjust the bleeder tee valves so that a slow, steady, non-aerated flow emanates from the bleeder tee weephole (approximately 100 ml/min).
- Collect the samples directly from the weephole into each of the required containers.
- Bottles should be filled in order of sensitivity to volatilization and oxidation as discussed in Section 5.1.3 or as outlined in project-specific planning documents. Care should be taken to ensure that no head space remains in the volatile organic vials. Certain other parameters may also require minimizing headspace (e.g., reduced or ferrous iron).
- Filtered samples can easily be obtained by installing an in-line, 0.45 µm disposable cartridge filter directly onto the pump discharge

Compressed Gas-Driven Piston Pump

A compressed gas-driven piston pump can be used for purging and sample collection in two-inch diameter wells at great depths. This type of pump is not typically dedicated. Collecting groundwater samples from these pumps is only appropriate if approved project-specific planning documents specifically include this technique for collecting samples

Required Equipment:

- Small diameter air driven pump
- Tubing of appropriate type and length
- Pump controller
- Compressed air source
- New disposable gloves of appropriate material
- New plastic sheeting

- Five gallon pail, graduated in minimum one gallon increments
- Water quality monitoring equipment (preferably a flow through cell).

Installation Instructions:

- Place new polyethylene (PE) sheet on suitable surface adjacent to well, taking care not to step on the PE sheet.
- Don a new pair of gloves.
- Decontaminate equipment and pump (if not dedicated) as outlined in decontamination SOP.
- Assemble the pump and tubing and lower into the well, being careful not to contact any surface other than the interior of the well or the plastic sheeting.
- Lower pump slowly into the well, being careful not to contact any surface other than the interior of the well or the plastic sheeting. When lowering the pump be particularly sensitive to areas that suggest drag or problems in the well where the pump could get stuck. If a problem exists do not continue, but discuss ways to investigate with PM or senior technical personnel.
- Place the pump intake as discussed in Section 5.4.2. Monitor the pump discharge and well hydraulics as discussed previously.

Purging Instructions:

- Connect the air source and pump controller to the pump.
- Determine the volume of water to be purged, as described above.
- Start the pump.
- Direct the pump discharge to the five gallon pail and determine the pumping rate.
- Continue pumping until the necessary volume of water has been purged from the well.

- If the pump intake has been placed deeply down into the water column for some reason, slowly withdraw the pump upward through the water column while it is still running to purge all water standing above the pump.
- Shut off the pump immediately whenever pump stops pumping water.
- Monitor indicator parameters as discussed previously.

Sampling Instructions:

- Allow the well to recharge after completion of purging, if necessary.
- Resume pumping and adjust to a slow pumping rate (approximately 100 ml/min).
- Collect the samples by pumping directly into each of the required containers.
- Bottles should be filled in order of sensitivity to volatilization and oxidation as discussed in Section 5.1.3 or as outlined in project-specific planning documents. Care should be taken to ensure that no head space remains in the volatile organic vials. Certain other parameters may also require minimizing headspace (e.g., reduced or ferrous iron).
- Filtered samples can easily be obtained by installing an in-line, 0.45 µm disposable cartridge filter directly onto the pump discharge.

Gasoline Powered Centrifugal Suction Pump

A two-cycle gasoline-engine-powered centrifugal pump provides an effective way to rapidly purge any well in which the depth to the pumped water level is less than about 20 to 25 feet. This type of pump is normally used with dedicated tubing. Groundwater sampling cannot be conducted using these pumps.

Required Equipment:

- Two-cycle gasoline-engine-powered centrifugal pump
- 1/2" to 3/4" PE tubing of appropriate length

- Flow control valve
- Check (foot) valve
- Supply of distilled or deionized water
- New disposable gloves of appropriate material
- New PE sheeting
- Five gallon pail, graduated in minimum one gallon increments
- Water quality monitoring equipment

Installation Instructions:

- Place new polyethylene (PE) sheet on suitable surface adjacent to well, taking care not to step on the PE sheet.
- Don a new pair of gloves.
- Decontaminate equipment such as hose (if not dedicated) as outlined in decontamination SOP.
- A check valve should be installed on the bottom of the tubing in order to prevent backflow of water into the well from the tubing and the pump after the pump is shut off. The check valve will also aid in priming the pump.
- Lower the tubing into well, being careful not to contact any surface other than the interior of the well or the PE sheeting. The outside of the tubing should be decontaminated following instructions in the Decontamination SOP.
- Place the intake of the tubing as high in the well as is possible but deep enough that it will not break suction.

Purging Instructions:

- Refuel the pump at a location that is remote from the well, being very careful not to spill any fuel on equipment or clothing that will be used at the well site. Pay strict attention to the required fuel mixture (gasoline/oil) that is specified by the pump manufacturer.

- Place the gasoline-powered compressor as far from the well as possible in a down-wind direction to eliminate potential exhaust impact to sampling.
- Connect the tubing to the pump.
- Don a new pair of gloves after handling the pump.
- Determine the volume of water to be purged, as described previously.
- Prime the pump using either distilled, deionized, or potable water. Use potable water only if the source has been tested analytically and found to be clear of the constituents of interest. Alternately, a pump equipped with a check valve on the tubing can be primed by working the tubing in an up and down motion, as with the inertial lift pump. This second approach should only be used if no other alternative is available for priming the pump.
- Start the pump.
- Direct the pump discharge to the five gallon pail and determine the pumping rate.
- Adjust the pumping rate to match the yield of the well.
- Continue pumping until the necessary volume of water has been purged from the well.
- If the pump intake tubing has been placed deeply down into the water column for some reason, slowly withdraw the tubing upward through the water column while it is still running to purge all water standing above the bottom intake.
- Dispose of the tubing after use, unless it is dedicated.
- Monitor indicator parameters as discussed previously.

Sampling Instructions:

- A centrifugal pump is not suitable and may not be used for sample collection.

Peristaltic Suction Pump

A peristaltic pump can be used to purge shallow, small diameter wells at a low to modest rate. The lift capacity is very limited with these pumps and often exceeded at groundwater depths of greater than 20 to 25 feet (depending upon pump size). This type of pump is normally used with dedicated tubing. Peristaltic pumps can also be used for sample collection for parameters that are not pH or pressure sensitive. Collecting groundwater samples from these pumps is only appropriate if approved project-specific planning documents specifically include this technique for collecting samples.

Required Equipment:

- Peristaltic pump, electric powered 12 VDC.
- 12 VDC power source, such as a sealed motorcycle battery or connection to vehicle battery.
- 3/8" to 1/2" PE, PP, or Teflon® tubing of appropriate length.
- 5/8" OD, 3/8" ID medical grade silicone tubing. Do not attempt to use Tygon® tubing.
- New disposable gloves of appropriate material.
- New PE sheeting.
- Five gallon pail, graduated in minimum one gallon increments.
- Water quality monitoring equipment (preferably a flow through cell).

Installation Instructions:

- Place new polyethylene (PE) sheet on suitable surface adjacent to well, taking care not to step on the PE sheet.
- Don a new pair of gloves.
- Replace the silicone tubing in the pump head if the pump will be used for sample collection.
- Lower the tubing into the well, being careful not to contact any surface other than the interior of the well or the plastic sheeting.

- Place the intake of the tubing as high in the well as possible but deep enough that it will not break suction.

Purging Instructions:

- Connect the tubing to the pump.
- Determine the volume of water to be purged, as described above.
- Start the pump.
- Direct the pump discharge to the five gallon pail and determine the pumping rate.
- Continue pumping until the necessary volume of water has been purged from the well.
- If the pump intake tubing has been placed deeply down into the water column for some reason, slowly withdraw the tubing upward through the water column while it is still running to purge all water standing above the bottom intake.
- Dispose of the tubing after use.
- Monitor indicator parameters as discussed previously.

Sampling Instructions:

- Allow the well to recharge after completion of purging, if necessary.
- Resume pumping and adjust to a slow pumping rate, (approximately 100 ml/min) if the pump is equipped with a speed control.
- Collect the samples by pumping directly into each of the required containers.
- Bottles should be filled in order of sensitivity to volatilization and oxidation as discussed in Section 5.1.3 or as outlined in project-specific planning documents. Care should be taken to ensure that no head space remains in the volatile organic vials. Certain other parameters may also require minimizing headspace (e.g., reduced or ferrous iron).

- Filtered samples can easily be obtained by installing an in-line, 0.45 µm disposable cartridge filter directly onto the pump discharge.

Inertial Lift Pump

An inertial lift pump is a very simple device that can be used to purge and sample wells of almost any diameter to a depth of approximately 100 feet. This type of pump is normally dedicated to the well. Collecting groundwater samples from these pumps is only appropriate if approved project-specific planning documents specifically include this technique for collecting samples.

Required Equipment:

- 1/2" OD HDPE pump tubing
- Check valve
- Electric motor driven lift arm [OPTIONAL]
- Electric power source [OPTIONAL]
- New disposable gloves of appropriate material
- New plastic sheeting
- Five gallon pail, graduated in minimum one gallon increments
- Water quality monitoring equipment (preferably a flow through cell).

Installation Instructions:

- Place new polyethylene (PE) sheet on suitable surface adjacent to well, taking care not to step on the PE sheet.
- Don a new pair of gloves.
- Decontaminate equipment and pump (if not dedicated) as outlined in decontamination SOP.
- Install self threading valve on the bottom of the tubing

- Lower pump slowly into the well, being careful not to contact any surface other than the interior of the well or the plastic sheeting. When lowering the pump be particularly sensitive to areas that suggest drag or problems in the well where the pump could get stuck. If a problem exists do not continue, but discuss ways to investigate with PM or senior technical personnel.
- Place the tubing intake as high in the well as is possible but deep enough that it will not break suction. The tubing intake can be placed deeper in the well if the inertial lift pump will also be used for sample collection.

Purging Instructions:

- Refuel the electric generator, if used, at a location that is remote from the well, being very careful not to spill any fuel on equipment or clothing that will be used at the well site.
- Place the generator as far from the well as possible in a down-wind direction.
- Don a new pair of gloves after handling the generator.
- Connect the tubing to the pump arm, if used.
- Determine the volume of water to be purged, as described above.
- Start pumping by working the pump tubing in an up and down motion.
- Direct the pump discharge to the five gallon pail and determine the pumping rate.
- Continue pumping until the necessary volume of water has been purged from the well.
- If the pump intake tubing has been placed deeply down into the water column for some reason, slowly withdraw the tubing upward through the water column while it is still running to purge all water standing above the bottom intake. This should be accomplished by reconnecting the pump arm at progressively lower points on the tubing and allowing the pump to

operate for short periods of time. This step is not required if the inertial lift pump will be used for sample collection.

- Dispose of the tubing after use, unless it is left in the well.
- Monitor indicator parameters as discussed previously.

Sampling Instructions:

- Allow the well to recharge after completion of purging, if necessary.
- Resume pumping at a slow rate either by decreasing the speed of the lift arm unit or by operating the tubing manually.
- Collect the samples by pumping directly into each of the required containers.
- Bottles should be filled in order of sensitivity to volatilization and oxidation as discussed in Section 5.1.3 or as outlined in project-specific planning documents. Care should be taken to ensure that no head space remains in the volatile organic vials. Certain other parameters may also require minimizing headspace (e.g., reduced or ferrous iron).
- Filtered samples can easily be obtained by installing an in-line, 0.45 µm disposable cartridge filter directly onto the pump discharge.

5.2.7 Field Measurements

The final determination of pH, specific conductance, and temperature should be made immediately upon collection of the samples. It is preferred that these parameters be measured continuously using a water quality meter coupled with a "flow through" cell. Alternately, these measurements would be made in an aliquot contained in a disposable plastic cup.

5.3 FIELD RECORDS

Accurate field records must be maintained to document groundwater sampling activities. These records include technical field data, sample identification labels, and chain-of-custody information for each sample. These records are described in detail in the following sections, and discussed in the Field Documentation and Sampling Handling SOPs.

Specifically for groundwater sampling, the field sampling records should include, at a minimum, the following information:

- Sampling location
- Date and time
- Condition of the well
- Static water level (depth to water)
- Depth to the bottom of the well
- Calculated well volume
- Purging method
- Actual purged volume
- Sample collection method
- Sample description
- Field meter calibration data
- Water quality measurements
- General comments (weather conditions, etc.)

All data entries should be made using black indelible ink and should be written legibly. Entry errors should be crossed out with a single line, dated, and initialed by the person making the correction.

5.4 SAMPLE SHIPMENT

Shipment of samples to an analytical laboratory is usually required upon completion of sample collection. Proper packaging is necessary in order to protect the sample containers, to maintain the samples at or below a temperature of 4°C, and to comply with all applicable transportation regulations. See the Sampling Handling and Management SOP for further details.

5.5 SPECIAL REGULATORY REQUIREMENTS

A number of states and USEPA regions have specific groundwater sampling requirements that must be followed. These requirements must be determined in advance, and should be incorporated in to the project specific planning documents.

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7.0 ATTACHMENTS

Attachment A - Groundwater Sampling Checklist

Attachment B - Summary of Well Purging Equipment

Attachment C - Summary of Well Sampling Equipment

Attachment D - Purging and Sampling Equipment Matrix

Attachment E – Example Groundwater Sampling Field Data Sheet

ATTACHMENTS

Attachment A. Groundwater Sampling Checklist

Planning

- ☐ Select well purging method
- ☐ Determine well purging strategy
 - ☐ Purging until of indicator parameters stabilize ($\pm 10\%$).
 - ☐ Purge predetermined number of well volumes (usually 3 to 5).
 - ☐ Low yield wells purged until dryness.
 - ☐ Others
- ☐ Determine containerization and disposal method for purge water
- ☐ Select well sampling method
- ☐ Determine groundwater sampling sequence

Preparatory Office Activities

- ☐ Obtain and decontaminate appropriate purging and sample collection equipment.
- ☐ Obtain appropriate sample containers and preservatives from laboratory.
- ☐ Inventory sample containers and preservatives.
- ☐ Pre-label sample containers.
- ☐ Initiate field data record for each well.
- ☐ Communicate sampling schedule with analytical laboratory and site contact or other parties, as required.

Preparatory Field Activities

- ☐ Perform well maintenance check.
- ☐ Prepare clean work area.
- ☐ Determine the depth to groundwater (± 0.02 ft).
- ☐ Calculate the water volume standing in the well ($\pm 2\%$).

Well Purging

- ☐ Place purging device at proper depth to ensure complete purging of well (if device is not also used for sample collection).
- ☐ Purge well, following previously selected strategy.
- ☐ Handle and dispose of purge water using previously determined method.

Well Sampling

- ☐ Collect groundwater sample.
- ☐ Fill containers and made field determinations in order of decreasing sensitivity to volatilization and/or pH change.
- ☐ Fill all other sample containers.
- ☐ Record all technical data.
- ☐ Maintain chain of custody records.
- ☐ Pack and ship samples to prevent breakage, to maintain sample temperature of 4°C and to comply with Dangerous Goods regulations.

Attachment B. Summary of Well Purging Equipment

Description	Pumping Rate (gpm)	Well Diam. (inches)	Depth Limit (feet)	Can it be Dedicated?	Materials	Advantages	Disadvantages	Manufacturers
Bailer								
Tube with bottom and/or top check valve, suspended by line.	0.2 - 2	Unlimited	Unlimited	Yes	<ul style="list-style-type: none"> • PVC • Teflon ® • HDPE • SS 	<ul style="list-style-type: none"> • Inexpensive • Simple • Can yield high quality samples • No power required • Easily cleaned 	<ul style="list-style-type: none"> • Awkward to use • Can aerate sample if not used carefully • Increases likelihood of turbid samples • Labor intensive 	Timco: Johnson: Voss:
Small Diameter (2") Electric Submersible Pump								
Electrically driven impeller pump.	0.1 - 9	2 - 4	75 - 300	Yes	<ul style="list-style-type: none"> • SS / Teflon ® 	<ul style="list-style-type: none"> • Relatively high pump rate • Effective for deep well purging 	<ul style="list-style-type: none"> • Requires 230 VAC power source • High capital cost • Deep sampling reduces efficiency 	Grundfos Fultz
Large Diameter (4") Electric Submersible Pump								
Electrically driven impeller pump.	4 - 20	> = 4	Unlimited	Not typically	<ul style="list-style-type: none"> • SS 	<ul style="list-style-type: none"> • High pump rate • Effective for deep wells • Moderate cost 	<ul style="list-style-type: none"> • Difficult to handle & decon. • Requires AC power source 	Grundfos
Peristaltic (Suction) Pump								
Elastic tubing that is sequentially squeezed by rollers.	1-3	< = 2	± 25	Yes, internal elastic tubing & pump tubing	<ul style="list-style-type: none"> • Teflon ® • HDPE • PP 	<ul style="list-style-type: none"> • Flow easily controlled • Portable • Inexpensive • Relatively simple 	<ul style="list-style-type: none"> • Requires power source • Slow purging rate 	Isco, Masterflex

NOTES:

SS: Stainless Steel
 HDPE: High density polyethylene
 PP: Polypropylene
 VAC: Voltage AC Source
 PVC: Polyvinyl Chloride
 TSS: Total Suspended Solids
 VOCs: Volatile Organic Compounds

Attachment C. Summary of Well Sampling Equipment

Description	Well Diam. (inches)	Depth Limit (feet)	Can it be Dedicated?	Materials	Reduce Flow to 100ml/m?	Acceptable for:		Advantages	Disadvantages	Manufacturers
						VOC	pH Sensitive			
Bailer										
Tube with bottom and/or top check valve, suspended by line.	Unlimited	Unlimited	Yes	<ul style="list-style-type: none">• PVC• Teflon ®• HDPE• SS	Yes	Yes	Yes	<ul style="list-style-type: none">• Simple, inexpensive• Can yield high quality samples if used carefully• No power required• Easily cleaned	<ul style="list-style-type: none">• Awkward to use• Can aerate sample if not used carefully• Increases chance of turbid samples• Flow not continuous	Timco: Johnson: Voss:
Small Diameter (2") Electric Submersible Pump										
Electrically driven impeller pump.	2 - 4	400	Yes	<ul style="list-style-type: none">• SS / Teflon ®	Yes	Yes	Yes	<ul style="list-style-type: none">• Easy to operate• Easy to control• Continuous flow	<ul style="list-style-type: none">• High capital cost• Awkward if not dedicated	Grundfos
Large Diameter (4") Electric Submersible Pump										
Electrically driven impeller pump.	>=4	unlimited	Not typically	<ul style="list-style-type: none">• SS	No	No	No	<ul style="list-style-type: none">• Continuous flow	<ul style="list-style-type: none">• May not be compatible with VOC & pressure sensitive parameters	Grundfos
Peristaltic (Suction) Pump										
Elastic tubing that is sequentially squeezed by rollers.	<=2	± 25	Yes, internal elastic tubing & pump tubing	<ul style="list-style-type: none">• Teflon ®• HDPE• PP	No	Yes		<ul style="list-style-type: none">• Flow rate easily controlled, continuo• Portable• Inexpensive• No pump contact with sample	<ul style="list-style-type: none">• Loss of VOC due to reduced pressure• Requires power source• May require priming• Can impede access	Isco, Masterflex

Notes:

SS: Stainless Steel VAC: Voltage AC Source VOCs: Volatile Organic Compounds
 HDPE: High density polyethylene PVC: Polyvinyl Chloride PP: Polyprplene

Attachment D - Purging and Sampling Equipment Matrix

Methods	4 inch wells						2 inch wells						<2 inch wells								
	Water Level < 20'				W.L. > 20'		Water Level < 20'				W.L. > 20'		Water Level < 20'				W.L. > 20'				
	Cs>0.2		Cs<0.2		Sample	Sample	Cs>0.2		Cs<0.2		Sample	Cs>0.2		Cs<0.2		Sample	Sample				
	Sample		Sample				Sample		Sample			Sample		Sample							
	Purging	VOC/pH Other	Purging	VOC/pH Other			Purging	VOC/pH Other	Purging	VOC/pH Other		Purging	VOC/pH Other	Purging	VOC/pH Other						
Methods Described in this SOP																					
Bailer	X	X	X	X	X	X	I	X	X	X	X	X	X	X	X	X	X	X	X	X	X
2" Electric Submersible Pump	X	X	X	X	X	X	X	X	X	X	X	X	X	X							
4" Electric Submersible Pump	X	O	X	X	O	X	X	O	X												
Peristaltic Pump	X	O	X							X	O	X				X	O	X			
Other Methods To Consider																					
Bladder Pump	X	X	X	X	X	X	I	X	X	X	X	X	X	X							
Gas Driven Piston Pump	X	X	X	X	X	X	I	X	X	X	X	X	X	X							
Centrifugal Pump	X									X						X					
Syringe Sampler		X	X		X	X		X	X		X	X		X	X						
Inertial Lift Pump	X	O	X	X	O	X	I	O	X	X	O	X	X	O	X	X	O	X	X	O	X

Notes: W.L. - Water Level

Cs - Specific Capacity (gallons per foot of drawdown)

VOC - Volatile Organic Compounds

X - Recommended method.

O - Conditionally acceptable Method, based upon technical concerns.

I - Inefficient method but technically acceptable.

- Not recommended or not feasible.

GROUNDWATER PURGE AND SAMPLING FIELD DATA SHEET

1. PROJECT INFORMATION								WELL ID: _____	
Project Number: _____ Task Number: _____				Date: _____		Time: _____			
Client: _____				Personnel: _____					
Project Location: _____				Weather: _____					

2. WELL DATA									
Casing Diameter: _____ inches				Type of Casing: _____					
Screen Diameter: _____ inches (d)				Type of Screen: _____ Screen Length : _____					
Total Depth of Well from TOC: _____ feet									
Depth to Static Water from TOC: _____ feet									
Depth to Product from TOC: _____ feet									
Length of Water Column (h): _____ feet Calculated Casing Volume: _____ gal (3 to 5 times one well volume)									
Purge Volume Calculation (one casing volume = $0.041d^2h$):									
Note: 2-inch well = 0.167 gal/ft 4-inch well = 0.667 gal/ft									

3. PURGE DATA								Equipment	
Purge Method: _____								Model(s)	
Materials: Pump/Bailer _____								1. _____	
Materials: Rope/Tubing _____								2. _____	
Was well purged dry? <input type="checkbox"/> Yes <input type="checkbox"/> No Pumping Rate: _____ gal/min									

Time	Cum. Gallons Removed	pH	Temp (Units)	Spec. Cond. (Units)	Eh (Units)	DO (Units)	Turbidity (NTU)	Other:	Comments

4. SAMPLING DATA								Analyses Requested:	
Method(s): _____									
Materials: Pump/Bailer _____									
Materials: Tubing/Rope _____									
Depth to Water at Time of Sampling: _____ Field Filtered? <input type="checkbox"/> Yes <input type="checkbox"/> No									
Sample ID: _____ Sample Time: _____ # of Containers: _____									
Duplicate Sample Collected? <input type="checkbox"/> Yes <input type="checkbox"/> No ID: _____									

5. COMMENTS									



Designation: D 1586 – 08a

Standard Test Method for Standard Penetration Test (SPT) and Split-Barrel Sampling of Soils¹

This standard is issued under the fixed designation D 1586; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (e) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the Department of Defense.

1. Scope²

1.1 This test method describes the procedure, generally known as the Standard Penetration Test (SPT), for driving a split-barrel sampler to obtain a representative disturbed soil sample for identification purposes, and measure the resistance of the soil to penetration of the sampler. Another method (Test Method D 3550) to drive a split-barrel sampler to obtain a representative soil sample is available but the hammer energy is not standardized.

1.2 Practice D 6066 gives a guide to determining the normalized penetration resistance of sands for energy adjustments of N-value to a constant energy level for evaluating liquefaction potential.

1.3 Test results and identification information are used to estimate subsurface conditions for foundation design.

1.4 Penetration resistance testing is typically performed at 5-foot depth intervals or when a significant change of materials is observed during drilling, unless otherwise specified.

1.5 This test method is limited to use in nonlithified soils and soils whose maximum particle size is approximately less than one-half of the sampler diameter.

1.6 This test method involves use of rotary drilling equipment (Guide D 5783, Practice D 6151). Other drilling and sampling procedures (Guide D 6286, Guide D 6169) are available and may be more appropriate. Considerations for hand driving or shallow sampling without boreholes are not addressed. Subsurface investigations should be recorded in accordance with Practice D 5434. Samples should be preserved and transported in accordance with Practice D 4220 using Group B. Soil samples should be identified by group name and symbol in accordance with Practice D 2488.

1.7 All observed and calculated values shall conform to the guidelines for significant digits and rounding established in Practice D 6026, unless superseded by this test method.

1.8 The values stated in inch-pound units are to be regarded as standard, except as noted below. The values given in

parentheses are mathematical conversions to SI units, which are provided for information only and are not considered standard.

1.8.1 The gravitational system of inch-pound units is used when dealing with inch-pound units. In this system, the pound (lbf) represents a unit of force (weight), while the unit for mass is slugs.

1.9 Penetration resistance measurements often will involve safety planning, administration, and documentation. This test method does not purport to address all aspects of exploration and site safety. *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.* Performance of the test usually involves use of a drill rig; therefore, safety requirements as outlined in applicable safety standards (for example, OSHA regulations,² NDA Drilling Safety Guide,³ drilling safety manuals, and other applicable state and local regulations) must be observed.

2. Referenced Documents

2.1 ASTM Standards:⁴

- D 653 Terminology Relating to Soil, Rock, and Contained Fluids
- D 854 Test Methods for Specific Gravity of Soil Solids by Water Pycnometer
- D 1587 Practice for Thin-Walled Tube Sampling of Soils for Geotechnical Purposes
- D 2216 Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
- D 2487 Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)
- D 2488 Practice for Description and Identification of Soils

² Available from Occupational Safety and Health Administration (OSHA), 200 Constitution Ave., NW, Washington, DC 20210, <http://www.osha.gov>.

³ Available from the National Drilling Association, 3511 Center Rd., Suite 8, Brunswick, OH 44212, <http://www.nda4u.com>.

⁴ For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

¹ This method is under the jurisdiction of ASTM Committee D18 on Soil and Rock and is the direct responsibility of Subcommittee D18.02 on Sampling and Related Field Testing for Soil Evaluations.

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*A Summary of Changes section appears at the end of this standard.

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- D 3550 Practice for Thick Wall, Ring-Lined, Split Barrel, Drive Sampling of Soils
- D 3740 Practice for Minimum Requirements for Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction
- D 4220 Practices for Preserving and Transporting Soil Samples
- D 4633 Test Method for Energy Measurement for Dynamic Penetrometers
- D 5434 Guide for Field Logging of Subsurface Explorations of Soil and Rock
- D 5783 Guide for Use of Direct Rotary Drilling with Water-Based Drilling Fluid for Geoenvironmental Exploration and the Installation of Subsurface Water-Quality Monitoring Devices
- D 6026 Practice for Using Significant Digits in Geotechnical Data
- D 6066 Practice for Determining the Normalized Penetration Resistance of Sands for Evaluation of Liquefaction Potential
- D 6151 Practice for Using Hollow-Stem Augers for Geotechnical Exploration and Soil Sampling
- D 6169 Guide for Selection of Soil and Rock Sampling Devices Used With Drill Rigs for Environmental Investigations
- D 6286 Guide for Selection of Drilling Methods for Environmental Site Characterization
- D 6913 Test Methods for Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis

3. Terminology

3.1 *Definitions:* Definitions of terms included in Terminology D 653 specific to this practice are:

3.1.1 *cathead, n*—the rotating drum or windlass in the rope-cathead lift system around which the operator wraps a rope to lift and drop the hammer by successively tightening and loosening the rope turns around the drum.

3.1.2 *drill rods, n*—rods used to transmit downward force and torque to the drill bit while drilling a borehole.

3.1.3 *N-value, n*—the blow count representation of the penetration resistance of the soil. The *N-value*, reported in blows per foot, equals the sum of the number of blows (*N*) required to drive the sampler over the depth interval of 6 to 18 in. (150 to 450 mm) (see 7.3).

3.1.4 *Standard Penetration Test (SPT), n*—a test process in the bottom of the borehole where a split-barrel sampler having an inside diameter of either 1-1/2-in. (38.1 mm) or 1-3/8-in. (34.9 mm) (see Note 2) is driven a given distance of 1.0 ft (0.30 m) after a seating interval of 0.5 ft (0.15 m) using a hammer weighing approximately 140-lbf (623-N) falling 30 ± 1.0 in. (0.76 m \pm 0.030 m) for each hammer blow.

3.2 Definitions of Terms Specific to This Standard:

3.2.1 *anvil, n*—that portion of the drive-weight assembly which the hammer strikes and through which the hammer energy passes into the drill rods.

3.2.2 *drive weight assembly, n*—an assembly that consists of the hammer, anvil, hammer fall guide system, drill rod attachment system, and any hammer drop system hoisting attachments.

3.2.3 *hammer, n*—that portion of the drive-weight assembly consisting of the 140 ± 2 lbf (623 ± 9 N) impact weight which is successively lifted and dropped to provide the energy that accomplishes the sampling and penetration.

3.2.4 *hammer drop system, n*—that portion of the drive-weight assembly by which the operator or automatic system accomplishes the lifting and dropping of the hammer to produce the blow.

3.2.5 *hammer fall guide, n*—that part of the drive-weight assembly used to guide the fall of the hammer.

3.2.6 *number of rope turns, n*—the total contact angle between the rope and the cathead at the beginning of the operator's rope slackening to drop the hammer, divided by 360° (see Fig. 1).

3.2.7 *sampling rods, n*—rods that connect the drive-weight assembly to the sampler. Drill rods are often used for this purpose.

4. Significance and Use

4.1 This test method provides a disturbed soil sample for moisture content determination, for identification and classification (Practices D 2487 and D 2488) purposes, and for laboratory tests appropriate for soil obtained from a sampler that will produce large shear strain disturbance in the sample such as Test Methods D 854, D 2216, and D 6913. Soil deposits containing gravels, cobbles, or boulders typically result in penetration refusal and damage to the equipment.

4.2 This test method provides a disturbed soil sample for moisture content determination and laboratory identification. Sample quality is generally not suitable for advanced laboratory testing for engineering properties. The process of driving the sampler will cause disturbance of the soil and change the engineering properties. Use of the thin wall tube sampler (Practice D 1587) may result in less disturbance in soft soils. Coring techniques may result in less disturbance than SPT sampling for harder soils, but it is not always the case, that is, some cemented soils may become loosened by water action during coring; see Practice D 6151, and Guide D 6169.

4.3 This test method is used extensively in a great variety of geotechnical exploration projects. Many local correlations and widely published correlations which relate blow count, or *N-value*, and the engineering behavior of earthworks and foundations are available. For evaluating the liquefaction potential of sands during an earthquake event, the *N-value* should be normalized to a standard overburden stress level. Practice D 6066 provides methods to obtain a record of normalized resistance of sands to the penetration of a standard sampler driven by a standard energy. The penetration resistance is adjusted to drill rod energy ratio of 60 % by using a hammer system with either an estimated energy delivery or directly measuring drill rod stress wave energy using Test Method D 4633.

NOTE 1—The reliability of data and interpretations generated by this practice is dependent on the competence of the personnel performing it

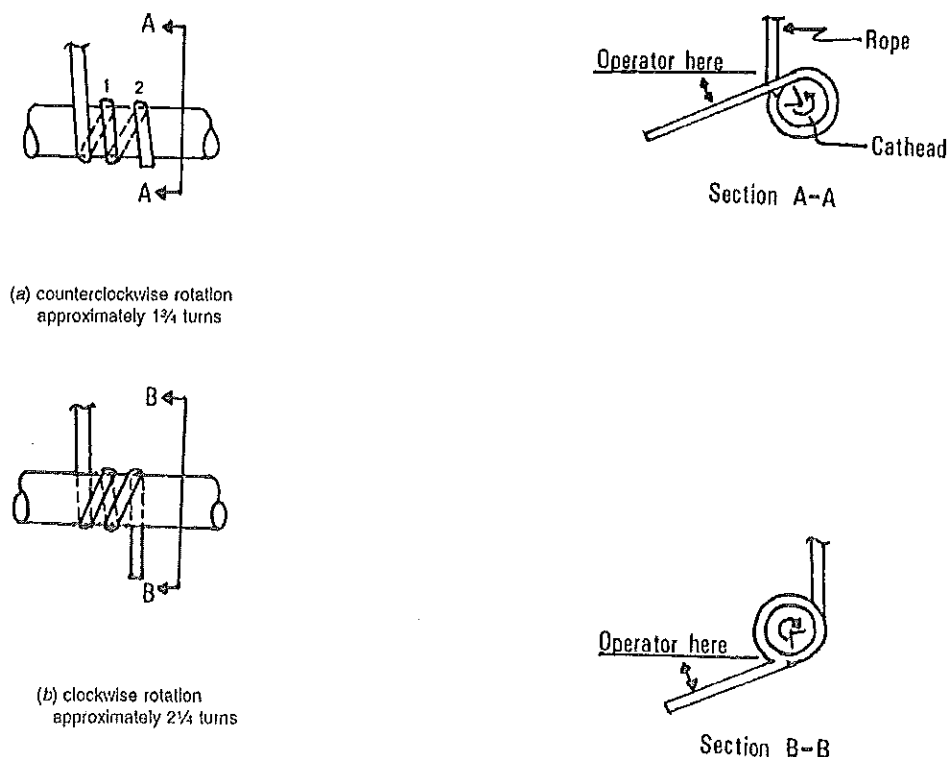


FIG. 1 Definitions of the Number of Rope Turns and the Angle for (a) Counterclockwise Rotation and (b) Clockwise Rotation of the Cathead



A = 1.0 to
B = 18.0 ft
C = 1.375
D = 1.50
E = 0.10
F = 2.00
G = 16.0°

and the suitability of the equipment and facilities used. Agencies that meet the criteria of Practice D 3740 generally are considered capable of competent testing. Users of this practice are cautioned that compliance with Practice D 3740 does not assure reliable testing. Reliable testing depends on several factors and Practice D 3740 provides a means of evaluating some of these factors. Practice D 3740 was developed for agencies engaged in the testing, inspection, or both, of soils and rock. As such, it is not totally applicable to agencies performing this practice. Users of this test method should recognize that the framework of Practice D 3740 is appropriate for evaluating the quality of an agency performing this test method. Currently, there is no known qualifying national authority that inspects agencies that perform this test method.

5. Apparatus

5.1 Drilling Equipment—Any drilling equipment that provides at the time of sampling a suitable borehole before insertion of the sampler and ensures that the penetration test is performed on intact soil shall be acceptable. The following pieces of equipment have proven to be suitable for advancing a borehole in some subsurface conditions:

5.1.1 Drag, Chopping, and Fishtail Bits, less than 6 1/2 in. (165 mm) and greater than 2 1/4 in. (57 mm) in diameter may be used in conjunction with open-hole rotary drilling or casing-advancement drilling methods. To avoid disturbance of the underlying soil, bottom discharge bits are not permitted; only side discharge bits are permitted.

5.1.2 Roller-Cone Bits, less than 6 1/2 in. (165 mm) and greater than 2 1/4 in. (57 mm) in diameter may be used in conjunction with open-hole rotary drilling or casing-advancement drilling methods if the drilling fluid discharge is deflected.

5.1.3 Hollow-Stem Continuous Flight Augers, with or without a center bit assembly, may be used to drill the borehole. The inside diameter of the hollow-stem augers shall be less than 6 1/2 in. (165 mm) and not less than 2 1/4 in. (57 mm).

5.1.4 Solid, Continuous Flight, Bucket and Hand Augers, less than 6 1/2 in. (165 mm) and not less than 2 1/4 in. (57 mm) in diameter may be used if the soil on the side of the borehole does not cave onto the sampler or sampling rods during sampling.

5.2 Sampling Rods—Flush-joint steel drill rods shall be used to connect the split-barrel sampler to the drive-weight assembly. The sampling rod shall have a stiffness (moment of inertia) equal to or greater than that of parallel wall "A" rod (a steel rod that has an outside diameter of 1-5/8 in. (41.3 mm) and an inside diameter of 1-1/8 in. (28.5 mm)).

5.3 Split-Barrel Sampler—The standard sampler dimensions are shown in Fig. 2. The sampler has an outside diameter of 2.00 in. (50.8 mm). The inside diameter of the of the split-barrel (dimension D in Fig. 2) can be either 1 1/2 in. (38.1

mm) or be used driving & repaired end of the sampler plastic b

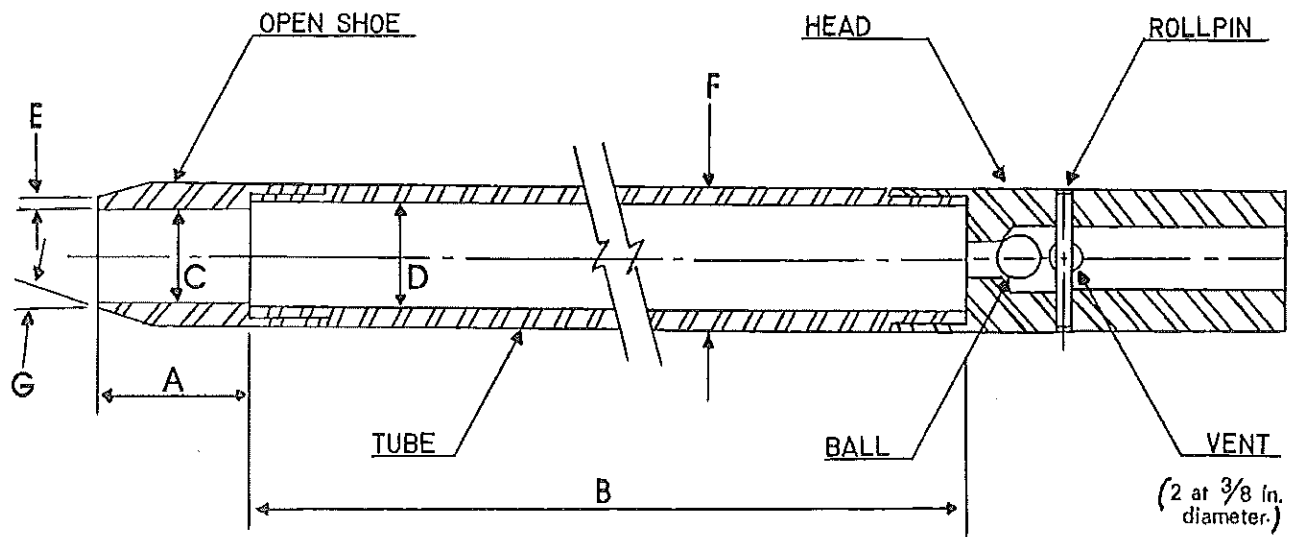
NOTE 2 differ as 1 and upset sampler r practice b one time, sampler retainers other cou original s

5.4 I

5.4.1

2 lbf (6 hammer when i unimpe hammer shall ha mm). Fi internal of the b more th

NOTE marked height.



- A = 1.0 to 2.0 in. (25 to 50 mm)
 B = 18.0 to 30.0 in. (0.457 to 0.762 m)
 C = 1.375 ± 0.005 in. (34.93 ± 0.13 mm)
 D = 1.50 ± 0.05 - 0.00 in. (38.1 ± 1.3 - 0.0 mm)
 E = 0.10 ± 0.02 in. (2.54 ± 0.25 mm)
 F = 2.00 ± 0.05 - 0.00 in. (50.8 ± 1.3 - 0.0 mm)
 G = 16.0° to 23.0°

FIG. 2 Split-Barrel Sampler

mm) or 1½-in. (34.9 mm) (see Note 2). A 16-gauge liner can be used inside the 1½-in. (38.1 mm) split barrel sampler. The driving shoe shall be of hardened steel and shall be replaced or repaired when it becomes dented or distorted. The penetrating end of the drive shoe may be slightly rounded. The split-barrel sampler must be equipped with a ball check and vent. Metal or plastic baskets may be used to retain soil samples.

NOTE 2—Both theory and available test data suggest that *N*-values may differ as much as 10 to 30 % between a constant inside diameter sampler and upset wall sampler. If it is necessary to correct for the upset wall sampler refer to Practice D 6066. In North America, it is now common practice to use an upset wall sampler with an inside diameter of 1½ in. At one time, liners were used but practice evolved to use the upset wall sampler without liners. Use of an upset wall sampler allows for use of retainers if needed, reduces inside friction, and improves recovery. Many other countries still use a constant ID split-barrel sampler, which was the original standard and still acceptable within this standard.

5.4 Drive-Weight Assembly:

5.4.1 *Hammer and Anvil*—The hammer shall weigh 140 ± 2 lbf (623 ± 9 N) and shall be a rigid metallic mass. The hammer shall strike the anvil and make steel on steel contact when it is dropped. A hammer fall guide permitting an unimpeded fall shall be used. Fig. 3 shows a schematic of such hammers. Hammers used with the cathead and rope method shall have an unimpeded over lift capacity of at least 4 in. (100 mm). For safety reasons, the use of a hammer assembly with an internal anvil is encouraged as shown in Fig. 3. The total mass of the hammer assembly bearing on the drill rods should not be more than 250 ± 10 lbf (113 ± 5 kg).

NOTE 3—It is suggested that the hammer fall guide be permanently marked to enable the operator or inspector to judge the hammer drop height.

5.4.2 *Hammer Drop System*—Rope-cathead, trip, semi-automatic or automatic hammer drop systems may be used, providing the lifting apparatus will not cause penetration of the sampler while re-engaging and lifting the hammer.

5.5 *Accessory Equipment*—Accessories such as labels, sample containers, data sheets, and groundwater level measuring devices shall be provided in accordance with the requirements of the project and other ASTM standards.

6. Drilling Procedure

6.1 The borehole shall be advanced incrementally to permit intermittent or continuous sampling. Test intervals and locations are normally stipulated by the project engineer or geologist. Typically, the intervals selected are 5 ft (1.5 m) or less in homogeneous strata with test and sampling locations at every change of strata. Record the depth of drilling to the nearest 0.1 ft (0.030 m).

6.2 Any drilling procedure that provides a suitably clean and stable borehole before insertion of the sampler and assures that the penetration test is performed on essentially intact soil shall be acceptable. Each of the following procedures has proven to be acceptable for some subsurface conditions. The subsurface conditions anticipated should be considered when selecting the drilling method to be used.

- 6.2.1 Open-hole rotary drilling method.
- 6.2.2 Continuous flight hollow-stem auger method.
- 6.2.3 Wash boring method.
- 6.2.4 Continuous flight solid auger method.

6.3 Several drilling methods produce unacceptable boreholes. The process of jetting through an open tube sampler and then sampling when the desired depth is reached shall not be

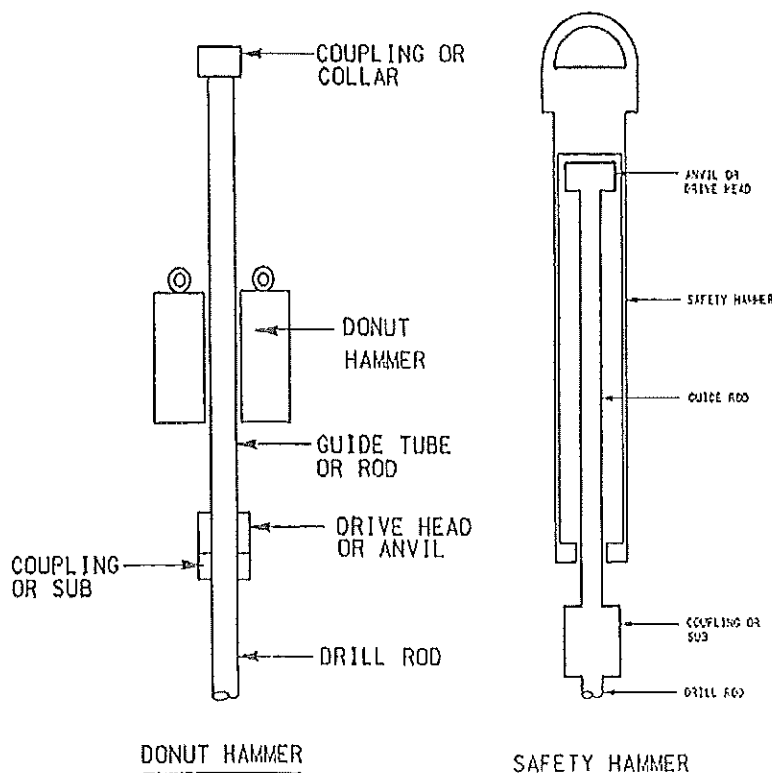


FIG. 3 Schematic Drawing of the Donut Hammer and Safety Hammer

permitted. The continuous flight solid auger method shall not be used for advancing the borehole below a water table or below the upper confining bed of a confined non-cohesive stratum that is under artesian pressure. Casing may not be advanced below the sampling elevation prior to sampling. Advancing a borehole with bottom discharge bits is not permissible. It is not permissible to advance the borehole for subsequent insertion of the sampler solely by means of previous sampling with the SPT sampler.

6.4 The drilling fluid level within the borehole or hollow-stem augers shall be maintained at or above the in situ groundwater level at all times during drilling, removal of drill rods, and sampling.

7. Sampling and Testing Procedure

7.1 After the borehole has been advanced to the desired sampling elevation and excessive cuttings have been removed, record the cleanout depth to the nearest 0.1 ft (0.030 m), and prepare for the test with the following sequence of operations:

7.1.1 Attach either split-barrel sampler Type A or B to the sampling rods and lower into the borehole. Do not allow the sampler to drop onto the soil to be sampled.

7.1.2 Position the hammer above and attach the anvil to the top of the sampling rods. This may be done before the sampling rods and sampler are lowered into the borehole.

7.1.3 Rest the dead weight of the sampler, rods, anvil, and drive weight on the bottom of the borehole. Record the sampling start depth to the nearest 0.1 ft (0.030 m). Compare the sampling start depth to the cleanout depth in 7.1. If

excessive cuttings are encountered at the bottom of the borehole, remove the sampler and sampling rods from the borehole and remove the cuttings.

7.1.4 Mark the drill rods in three successive 0.5-foot (0.15 m) increments so that the advance of the sampler under the impact of the hammer can be easily observed for each 0.5-foot (0.15 m) increment.

7.2 Drive the sampler with blows from the 140-lbf (623-N) hammer and count the number of blows applied in each 0.5-foot (0.15-m) increment until one of the following occurs:

7.2.1 A total of 50 blows have been applied during any one of the three 0.5-foot (0.15-m) increments described in 7.1.4.

7.2.2 A total of 100 blows have been applied.

7.2.3 There is no observed advance of the sampler during the application of 10 successive blows of the hammer.

7.2.4 The sampler is advanced the complete 1.5 ft. (0.45 m) without the limiting blow counts occurring as described in 7.2.1, 7.2.2, or 7.2.3.

7.2.5 If the sampler sinks under the weight of the hammer, weight of rods, or both, record the length of travel to the nearest 0.1 ft (0.030 m), and drive the sampler through the remainder of the test interval. If the sampler sinks the complete interval, stop the penetration, remove the sampler and sampling rods from the borehole, and advance the borehole through the very soft or very loose materials to the next desired sampling elevation. Record the N -value as either weight of hammer, weight of rods, or both.

7.3 Record the number of blows (N) required to advance the sampler each 0.5-foot (0.15 m) of penetration or fraction

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thereof. The first 0.5-foot (0.15 m) is considered to be a seating drive. The sum of the number of blows required for the second and third 0.5-foot (0.15 m) of penetration is termed the "standard penetration resistance," or the "*N*-value." If the sampler is driven less than 1.5 ft (0.45 m), as permitted in 7.2.1, 7.2.2, or 7.2.3, the number of blows per each complete 0.5-foot (0.15 m) increment and per each partial increment shall be recorded on the boring log. For partial increments, the depth of penetration shall be reported to the nearest 0.1 ft (0.030 m) in addition to the number of blows. If the sampler advances below the bottom of the borehole under the static weight of the drill rods or the weight of the drill rods plus the static weight of the hammer, this information should be noted on the boring log.

7.4 The raising and dropping of the 140-lbf (623-N) hammer shall be accomplished using either of the following two methods. Energy delivered to the drill rod by either method can be measured according to procedures in Test Method D 4633.

7.4.1 *Method A*—By using a trip, automatic, or semi-automatic hammer drop system that lifts the 140-lbf (623-N) hammer and allows it to drop 30 ± 1.0 in. ($0.76 \text{ m} \pm 0.030 \text{ m}$) with limited unimpedence. Drop heights adjustments for automatic and trip hammers should be checked daily and at first indication of variations in performance. Operation of automatic hammers shall be in strict accordance with operations manuals.

7.4.2 *Method B*—By using a cathead to pull a rope attached to the hammer. When the cathead and rope method is used the system and operation shall conform to the following:

7.4.2.1 The cathead shall be essentially free of rust, oil, or grease and have a diameter in the range of 6 to 10 in. (150 to 250 mm).

7.4.2.2 The cathead should be operated at a minimum speed of rotation of 100 RPM.

7.4.2.3 The operator should generally use either 1-3/4 or 2-1/4 rope turns on the cathead, depending upon whether or not the rope comes off the top (1-3/4 turns for counterclockwise rotation) or the bottom (2-1/4 turns for clockwise rotation) of the cathead during the performance of the penetration test, as shown in Fig. 1. It is generally known and accepted that 2-3/4 or more rope turns considerably impedes the fall of the hammer and should not be used to perform the test. The cathead rope should be stiff, relatively dry, clean, and should be replaced when it becomes excessively frayed, oily, limp, or burned.

7.4.2.4 For each hammer blow, a 30 ± 1.0 in. ($0.76 \text{ m} \pm 0.030 \text{ m}$) lift and drop shall be employed by the operator. The operation of pulling and throwing the rope shall be performed rhythmically without holding the rope at the top of the stroke.

NOTE 4—If the hammer drop height is something other than 30 ± 1.0 in. ($0.76 \text{ m} \pm 0.030 \text{ m}$), then record the new drop height. For soils other than sands, there is no known data or research that relates to adjusting the *N*-value obtained from different drop heights. Test method D 4633 provides information on making energy measurement for variable drop heights and Practice D 6066 provides information on adjustment of *N*-value to a constant energy level (60 % of theoretical, *N*₆₀). Practice D 6066 allows the hammer drop height to be adjusted to provide 60 % energy.

7.5 Bring the sampler to the surface and open. Record the percent recovery to the nearest 1 % or the length of sample recovered to the nearest 0.01 ft (5 mm). Classify the soil

samples recovered as to, in accordance with Practice D 2488, then place one or more representative portions of the sample into sealable moisture-proof containers (jars) without ramming or distorting any apparent stratification. Seal each container to prevent evaporation of soil moisture. Affix labels to the containers bearing job designation, boring number, sample depth, and the blow count per 0.5-foot (0.15-m) increment. Protect the samples against extreme temperature changes. If there is a soil change within the sampler, make a jar for each stratum and note its location in the sampler barrel. Samples should be preserved and transported in accordance with Practice D 4220 using Group B.

8. Data Sheet(s)/Form(s)

8.1 Data obtained in each borehole shall be recorded in accordance with the Subsurface Logging Guide D 5434 as required by the exploration program. An example of a sample data sheet is included in Appendix X1.

8.2 Drilling information shall be recorded in the field and shall include the following:

- 8.2.1 Name and location of job,
- 8.2.2 Names of crew,
- 8.2.3 Type and make of drilling machine,
- 8.2.4 Weather conditions,
- 8.2.5 Date and time of start and finish of borehole,
- 8.2.6 Boring number and location (station and coordinates, if available and applicable),
- 8.2.7 Surface elevation, if available,
- 8.2.8 Method of advancing and cleaning the borehole,
- 8.2.9 Method of keeping borehole open,
- 8.2.10 Depth of water surface to the nearest 0.1 ft (0.030 m) and drilling depth to the nearest 0.1 ft (0.030 m) at the time of a noted loss of drilling fluid, and time and date when reading or notation was made,
- 8.2.11 Location of strata changes, to the nearest 0.5 ft (15 cm),
- 8.2.12 Size of casing, depth of cased portion of borehole to the nearest 0.1 ft (0.030 m),
- 8.2.13 Equipment and Method A or B of driving sampler,
- 8.2.14 Sampler length and inside diameter of barrel, and if a sample basket retainer is used,
- 8.2.15 Size, type, and section length of the sampling rods, and
- 8.2.16 Remarks.

8.3 Data obtained for each sample shall be recorded in the field and shall include the following:

- 8.3.1 Top of sample depth to the nearest 0.1 ft (0.030 m) and, if utilized, the sample number,
- 8.3.2 Description of soil,
- 8.3.3 Strata changes within sample,
- 8.3.4 Sampler penetration and recovery lengths to the nearest 0.1 ft (0.030 m), and
- 8.3.5 Number of blows per 0.5 foot (0.015 m) or partial increment.

9. Precision and Bias

9.1 *Precision*—Test data on precision is not presented due to the nature of this test method. It is either not feasible or too

costly at this time to have ten or more agencies participate in an in situ testing program at a given site.

9.1.1 The Subcommittee 18.02 is seeking additional data from the users of this test method that might be used to make a limited statement on precision. Present knowledge indicates the following:

9.1.1.1 Variations in N -values of 100 % or more have been observed when using different standard penetration test apparatus and drillers for adjacent boreholes in the same soil formation. Current opinion, based on field experience, indicates that when using the same apparatus and driller, N -values in the same soil can be reproduced with a coefficient of variation of about 10 %.

9.1.1.2 The use of faulty equipment, such as an extremely massive or damaged anvil, a rusty cathead, a low speed cathead, an old, oily rope, or massive or poorly lubricated rope sheaves can significantly contribute to differences in N -values obtained between operator-drill rig systems.

9.2 *Bias*—There is no accepted reference value for this test method, therefore, bias cannot be determined.

10. Keywords

10.1 blow count; in-situ test; penetration resistance; soil; split-barrel sampling; standard penetration test

APPENDIX

(Nonmandatory Information)

X1. Example Data Sheet

X1.1 See Fig. 4.

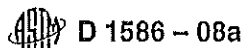
[illegible]

FIG. 4 Example Data Sheet



SUMMARY OF CHANGES

Committee D18 has identified the location of selected changes to this standard since the last issue (D 1586 – 08) that may impact the use of this standard. (Approved October 1, 2008.)

- (1) Removed previous Figure 4.
- (2) Replaced “undisturbed” with “intact” in Sections 5.1 and 6.2.

Committee D18 has identified the location of selected changes to this standard since the last issue (D 1586 – 99) that may impact the use of this standard. (Approved February 1, 2008.)

- (1) There have been numerous changes to this standard to list them separately. From the most recent main ballot process, additional changes were requested and incorporated into this newest revision. Stated below is a highlight of some of the changes.
- (2) Scope was completely revised.
- (3) Referenced Documents updated to include new standards.
- (4) Terminology: added section on Definitions.
- (5) Significance and Use: clarified use of the SPT test.
- (6) Apparatus: general editorial changes.
- (7) Sampling and Testing Procedure: general editorial changes.
- (8) Data Sheets/Forms: general editorial changes.
- (9) Precision and Bias: added Sections 9.1.1.1 and 9.1.1.2.

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Designation: D 1587 – 08

Standard Practice for Thin-Walled Tube Sampling of Soils for Geotechnical Purposes¹

This standard is issued under the fixed designation D 1587; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the Department of Defense.

1. Scope²

1.1 This practice covers a procedure for using a thin-walled metal tube to recover relatively intact soil samples suitable for laboratory tests of engineering properties, such as strength, compressibility, permeability, and density. Thin-walled tubes used in piston, plug, or rotary-type samplers should comply with Section 6.3 of this practice which describes the thin-walled tubes.

NOTE 1—This practice does not apply to liners used within the samplers.

1.2 This Practice is limited to soils that can be penetrated by the thin-walled tube. This sampling method is not recommended for sampling soils containing gravel or larger size soil particles cemented or very hard soils. Other soil samplers may be used for sampling these soil types. Such samplers include driven split barrel samplers and soil coring devices (D 1586, D 3550, and D 6151). For information on appropriate use of other soil samplers refer to D 6169.

1.3 This practice is often used in conjunction with fluid rotary drilling (D 1452, D 5783) or hollow-stem augers (D 6151). Subsurface geotechnical explorations should be reported in accordance with practice (D 5434). This practice discusses some aspects of sample preservation after the sampling event. For information on preservation and transportation process of soil samples, consult Practice D 4220. This practice does not address environmental sampling; consult D 6169 and D 6232 for information on sampling for environmental investigations.

1.4 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.4.1 The tubing tolerances presented in Table 1 are from sources available in North America. Use of metric equivalent is

acceptable as long as thickness and proportions are similar to those required in this standard.

1.5 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

1.6 This practice offers a set of instructions for performing one or more specific operations. This document cannot replace education or experience and should be used in conjunction with professional judgment. Not all aspects of this practice may be applicable in all circumstances. This ASTM standard is not intended to represent or replace the standard of care by which the adequacy of a given professional service must be judged, nor should this document be applied without consideration of a project's many unique aspects. The word "Standard" in the title of this document means only that the document has been approved through the ASTM consensus process.

2. Referenced Documents

2.1 ASTM Standards:²

- D 653 Terminology Relating to Soil, Rock, and Contained Fluids
- D 1452 Practice for Soil Investigation and Sampling by Auger Borings
- D 1586 Test Method for Penetration Test (SPT) and Split-Barrel Sampling of Soils
- D 2488 Practice for Description and Identification of Soils (Visual-Manual Procedure)
- D 3550 Practice for Thick Wall, Ring-Lined, Split Barrel, Drive Sampling of Soils
- D 3740 Practice for Minimum Requirements for Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction
- D 4220 Practices for Preserving and Transporting Soil Samples

¹ This practice is under the jurisdiction of ASTM Committee D18 on Soil and Rock and is the direct responsibility of Subcommittee D18.02 on Sampling and Related Field Testing for Soil Evaluations.

Current edition approved Oct. 1, 2008. Published October 2008. Originally approved in 1958. Last previous edition approved in 2007 as D 1587 – 00 (2007) ^{ϵ 1}

² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

*A Summary of Changes section appears at the end of this standard.

TABLE 1 Dimensional Tolerances for Thin-Walled Tubes

Nominal Tube Diameters from Table 2 ^A Tolerances						
Size Outside Diameter	2 in.	50.8 mm	3 in.	76.2 mm	5 in.	127 mm
Outside diameter, D_o	+0.007 -0.000	+0.179 -0.000	+0.010 -0.000	+0.254 -0.000	+0.015 -0.000	0.381 -0.000
Inside diameter, D_i	+0.000 -0.007	+0.000 -0.179	+0.000 -0.010	+0.000 -0.254	+0.000 -0.015	+0.000 -0.381
Wall thickness	± 0.007	± 0.179	± 0.010	± 0.254	± 0.015	± 0.381
Ovality	0.015	0.381	0.020	0.508	0.030	0.762
Straightness	0.030/ft	2.50/m	0.030/ft	2.50/m	0.030/ft	2.50/m

^A Intermediate or larger diameters should be proportional. Specify only two of the first three tolerances; that is, D_o and D_i , or D_o and Wall thickness, or D_i and Wall thickness.

D 5434 Guide for Field Logging of Subsurface Explorations of Soil and Rock

D 5783 Guide for Use of Direct Rotary Drilling with Water-Based Drilling Fluid for Geoenvironmental Exploration and the Installation of Subsurface Water-Quality Monitoring Devices

D 6151 Practice for Using Hollow-Stem Augers for Geotechnical Exploration and Soil Sampling

D 6169 Guide for Selection of Soil and Rock Sampling Devices Used With Drill Rigs for Environmental Investigations

D 6232 Guide for Selection of Sampling Equipment for Waste and Contaminated Media Data Collection Activities

3. Terminology

3.1 Definitions:

3.1.1 For common definitions of terms in this standard, refer to Terminology D 653.

3.2 Definitions of Terms Specific to This Standard:

3.2.1 *inside clearance ratio*, %, n —the ratio of the difference in the inside diameter of the tube, D_i , minus the inside diameter of the cutting edge, D_c , to the inside diameter of the tube, D_i expressed as a percentage (see Fig. 1).

3.2.2 *ovality*, n —the cross section of the tube that deviates from a perfect circle.

4. Summary of Practice

4.1 A relatively intact sample is obtained by pressing a thin-walled metal tube into the in-situ soil at the bottom of a boring, removing the soil-filled tube, and applying seals to the soil surfaces to prevent soil movement and moisture gain or loss.

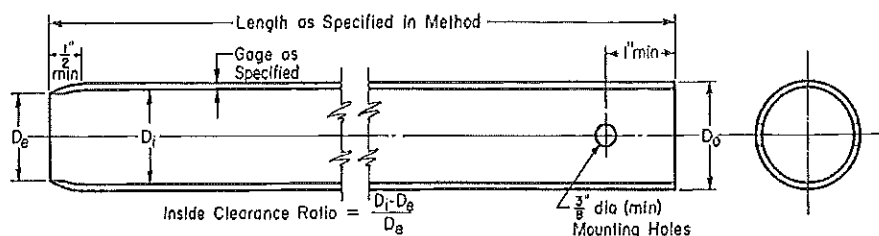
5. Significance and Use

5.1 This practice, or Practice D 3550 with thin wall shoe, is used when it is necessary to obtain a relatively intact specimen suitable for laboratory tests of engineering properties or other tests that might be influenced by soil disturbance.

NOTE 2—The quality of the result produced by this standard is dependent on the competence of the personnel performing it, and the suitability of the equipment and facilities used. Agencies that meet the criteria of Practice D 3740 are generally considered capable of competent and objective sampling. Users of this practice, are cautioned that compliance with Practice D 3740 does not in itself assure reliable results. Reliable results depend on many factors; Practice D 3740 provides a means of evaluating some of those factors.

6. Apparatus

6.1 *Drilling Equipment*—When sampling in a boring, any drilling equipment may be used that provides a reasonably clean hole; that minimizes disturbance of the soil to be sampled; and that does not hinder the penetration of the thin-walled sampler. Open borehole diameter and the inside



NOTE 1—Minimum of two mounting holes on opposite sides for D_o smaller than 4 in. (101.6 mm).

NOTE 2—Minimum of four mounting holes equally spaced for D_o 4 in. (101.6 mm) and larger.

NOTE 3—Tube held with hardened screws or other suitable means.

NOTE 4—2-in (50.8 mm) outside-diameter tubes are specified with an 18-gauge wall thickness to comply with area ratio criteria accepted for "intact samples." Users are advised that such tubing is difficult to locate and can be extremely expensive in small quantities. Sixteen-gauge tubes are generally readily available.

Metric Equivalent Conversions

in.	mm
3/8	9.53
1/2	12.7
1	25.4
2	50.8
3	76.2
4	101.6
5	127

FIG. 1 Thin-Walled Tube for Sampling

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TABLE 2 Suitable Thin-Walled Steel Sample Tubes^A

Outside diameter (D _o):			
in.	2	3	5
mm	50.8	76.2	127
Wall thickness:			
Bwg	18	16	11
in.	0.049	0.065	0.120
mm	1.24	1.65	3.05
Tube length:			
in.	36	36	64
m	0.91	0.91	1.45
Inside clearance ratio, %	<1	<1	<1

^A The three diameters recommended in Table 2 are indicated for purposes of standardization, and are not intended to indicate that sampling tubes of intermediate or larger diameters are not acceptable. Lengths of tubes shown are illustrative. Proper lengths to be determined as suited to field conditions.

diameter of driven casing or hollow stem auger shall not exceed 3.5 times the outside diameter of the thin-walled tube.

6.2 *Sampler Insertion Equipment*, shall be adequate to provide a relatively rapid continuous penetration force. For hard formations it may be necessary, although not recommended, to drive the thin-walled tube sampler.

6.3 *Thin-Walled Tubes*, should be manufactured to the dimensions as shown in Fig. 1. They should have an outside diameter of 2 to 5 in. (50 to 130 mm) and be made of metal having adequate strength for the type of soil to be sampled. Tubes shall be clean and free of all surface irregularities including projecting weld seams. Other diameters may be used but the tube dimensions should be proportional to the tube designs presented here.

6.3.1 *Length of Tubes*—See Table 2 and 7.4.1.

6.3.2 *Tolerances*, shall be within the limits shown in Table 1.

6.3.3 *Inside Clearance Ratio*, should be not greater than 1% unless specified otherwise for the type of soil to be sampled. Generally, the inside clearance ratio used should increase with the increase in plasticity of the soil being sampled, except for sensitive soils or where local experience indicates otherwise. See 3.2.1 and Fig. 1 for definition of inside clearance ratio.

6.3.4 *Corrosion Protection*—Corrosion, whether from galvanic or chemical reaction, can damage or destroy both the thin-walled tube and the sample. Severity of damage is a function of time as well as interaction between the sample and the tube. Thin-walled tubes should have some form of protective coating, unless the soil is to be extruded less than 3 days. The type of coating to be used may vary depending upon the material to be sampled. Plating of the tubes or alternate base metals may be specified. Galvanized tubes are often used when long term storage is required. Coatings may include a light coat of lubricating oil, lacquer, epoxy, Teflon, zinc oxide, and others.

NOTE 3—Most coating materials are not resistant to scratching by soils that contain sands. Consideration should be given for prompt testing of the sample because chemical reactions between the metal and the soil sample can occur with time.

6.4 *Sampler Head*, serves to couple the thin-walled tube to the insertion equipment and, together with the thin-walled tube, comprises the thin-walled tube sampler. The sampler head shall contain a venting area and suitable check valve with the

venting area to the outside equal to or greater than the area through the check valve. In some special cases, a check valve may not be required but venting is required to avoid sample compression. Attachment of the head to the tube shall be concentric and coaxial to assure uniform application of force to the tube by the sampler insertion equipment.

7. Procedure

7.1 Remove loose material from the center of a casing or hollow stem auger as carefully as possible to avoid disturbance of the material to be sampled. If groundwater is encountered, maintain the liquid level in the borehole at or above ground water level during the drilling and sampling operation.

7.2 Bottom discharge bits are not permitted. Side discharge bits may be used, with caution. Jetting through an open-tube sampler to clean out the borehole to sampling elevation is not permitted.

NOTE 4—Roller bits are available in downward-jetting and diffused-jet configurations. Downward-jetting configuration rock bits are not acceptable. Diffuse-jet configurations are generally acceptable.

7.3 Lower the sampling apparatus so that the sample tube's bottom rests on the bottom of the hole and record depth to the bottom of the sample tube to the nearest 0.1-ft (0.03 m).

7.3.1 Keep the sampling apparatus plumb during lowering, thereby preventing the cutting edge of the tube from scraping the wall of the borehole.

7.4 Advance the sampler without rotation by a continuous relatively rapid downward motion and record length of advancement to the nearest 1 in. (25 mm).

7.4.1 Determine the length of advance by the resistance and condition of the soil formation, but the length shall never exceed 5 to 10 diameters of the tube in sands and 10 to 15 diameters of the tube in clays. In no case shall a length of advance be greater than the sample-tube length minus an allowance for the sampler head and a minimum of 3 in. (76 mm) for sludge and end cuttings.

NOTE 5—The mass of sample, laboratory handling capabilities, transportation problems, and commercial availability of tubes will generally limit maximum practical lengths to those shown in Table 2.

7.5 When the soil formation is too hard for push-type insertion, the tube may be driven or Practice D 3550 may be used. If driving methods are used, the data regarding weight and fall of the hammer and penetration achieved must be shown in the report. Additionally, that tube must be prominently labeled a "driven sample."

7.6 Withdraw the sampler from the soil formation as carefully as possible in order to minimize disturbance of the sample. The tube can be slowly rotated to shear the material at the end of the tube, and to relieve water or suction pressures (or both) and improve recovery. Where the soil formation is soft, a delay before withdraw of the sampler (typically 5 to 30 minutes) may improve sample recovery.

8. Sample Measurement, Sealing and Labeling

8.1 Upon removal of the tube, remove the drill cuttings in the upper end of the tube and measure the length of the soil sample recovered to the nearest 0.25 in. (6 mm) in the tube. Seal the upper end of the tube. Remove at least 1 in. (25 mm)

of material from the lower end of the tube. Use this material for soil description in accordance with Practice D 2488. Measure the overall sample length. Seal the lower end of the tube. Alternatively, after measurement, the tube may be sealed without removal of soil from the ends of the tube.

8.1.1 Tubes sealed over the ends, as opposed to those sealed with expanding packers, should be provided with spacers or appropriate packing materials, or both prior to sealing the tube ends to provide proper confinement. Packing materials must be nonabsorbent and must maintain their properties to provide the same degree of sample support with time.

8.1.2 Depending on the requirements of the investigation, field extrusion and packaging of extruded soil samples can be performed. This allows for physical examination and classification of the sample. Samples are extruded in special hydraulic jacks equipped with properly sized platens to extrude the core in a continuous smooth speed. In some cases, further extrusion may cause sample disturbance reducing suitability for testing of engineering properties. In other cases, if damage is not significant, cores can be extruded and preserved for testing (Practice D 4220). Bent or damaged tubes should be cut off before extruding.

8.2 Prepare and immediately affix labels or apply markings as necessary to identify the sample (see Section 9). Assure that the markings or labels are adequate to survive transportation and storage.

NOTE 6—Top end of the tube should be labeled "top."

9. Field Log

9.1 Record the information that may be required for preparing field logs in general accordance to Guide D 5434. This

guide is used for logging explorations by drilling and sampling. Some examples of the information required include;

- 9.1.1 Name and location of the project,
- 9.1.2 Boring number,
- 9.1.3 Log of the soil conditions,
- 9.1.4 Surface elevation or reference to a datum to the nearest foot (0.5 m) or better,
- 9.1.5 Location of the boring,
- 9.1.6 Method of making the borehole,
- 9.1.7 Name of the drilling foreman and company, and
- 9.1.8 Name of the drilling inspector(s).
- 9.1.9 Date and time of boring-start and finish,
- 9.1.10 Depth to groundwater level; date and time measured,
- 9.2 Recording the appropriate sampling information is required as follows:
 - 9.2.1 Depth to top of sample to the nearest 0.1 ft. (.03 m) and number of sample,
 - 9.2.2 Description of thin-walled tube sampler: size, type of metal, type of coating,
 - 9.2.3 Method of sampler insertion: push or drive,
 - 9.2.4 Method of drilling, size of hole, casing, and drilling fluid used,
 - 9.2.5 Soil description in accordance with Practice D 2488,
 - 9.2.6 Length of sampler advance (push), and
 - 9.2.7 Recovery: length of sample obtained.

10. Keywords

10.1 geologic investigations; intact; sampling; soil exploration; soil investigations; subsurface investigations

SUMMARY OF CHANGES

Committee D18 has identified the location of selected changes to this standard since the last issue (D 1587 - 00 (2007)^{e1}) that may impact the use of this standard. (Approved October 1, 2008.)

(1) Replaced "undisturbed" with "intact" in Sections 1.1, 4.1, 5.1, 10, and Note 4 of Fig. 1.

(2) Editorial changes made in Sections 1.4, 7.3, 7.4.1, 7.6, 8.1, and 8.1.2.

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1. Scope

1.1 This standard is intended for use in the field for the purpose of obtaining soil samples for testing in the laboratory. It is not intended for use in the laboratory for the purpose of obtaining soil samples for testing in the field. It is not intended for use in the laboratory for the purpose of obtaining soil samples for testing in the field.

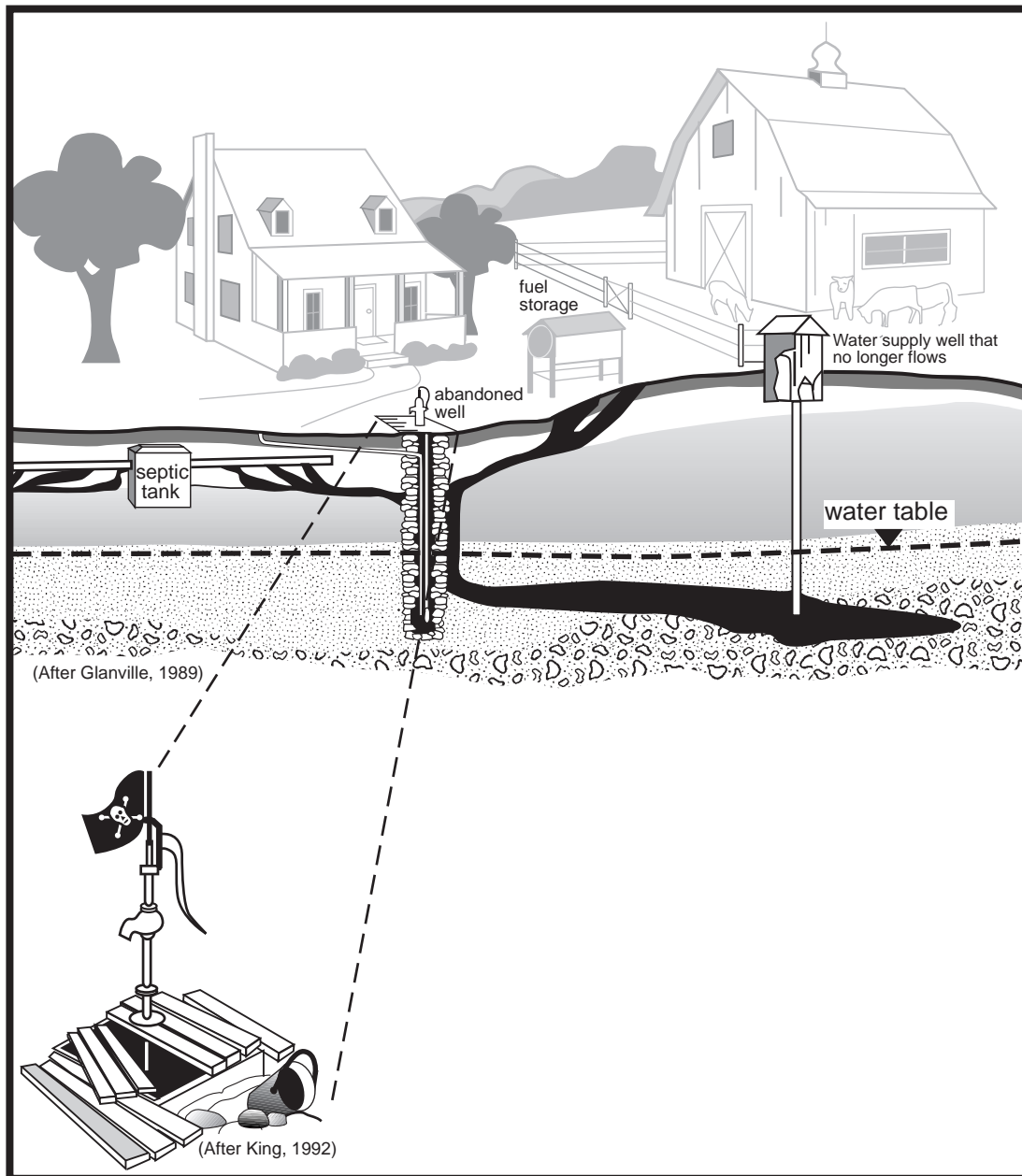
2. Referenced

2.1 This standard is referenced in the following documents: C 12, G 1, C 61, and M 1.

¹ This standard is referenced in the following documents: Rock and Soil Sampling, C 12, G 1, C 61, and M 1. ² For information on the current approved edition, contact ASTM International at the address shown below.

ATTACHMENT B - ODNR WELL ABANDONMENT GUIDANCE

State of Ohio Technical Guidance for Sealing Unused Wells



by the
State Coordinating Committee on Ground Water
1996

TECHNICAL GUIDANCE FOR SEALING UNUSED WELLS

BY THE

**STATE COORDINATING COMMITTEE ON GROUND WATER
1996**

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Preface

In early 1992, Ohio's State Coordinating Committee on Ground Water identified a list of major issues and problems that they determined should be addressed in some form by the Committee. The issue of the lack of consistent standards and regulations regarding the sealing of abandoned wells and test borings was identified as a major issue of concern by the Committee. The Natural Resource Conservation Service (NRCS, formerly the Soil Conservation Service) approached the Committee in the spring of 1994 regarding a new USDA cost sharing program for sealing abandoned wells that could be implemented by the states. The program required that the states develop technical standards that would be adopted by the state technical committee at the NRCS. Once these technical standards were adopted, counties participating in the cost share program could choose to offer cost share funds to farmers for sealing abandoned wells on agricultural properties. Based on this new opportunity from the NRCS, and due to increasing concerns by many of the participating state agencies and the well drilling industry, the Committee decided to form a workgroup in June, 1994 to develop consistent technical standards for sealing abandoned wells and test borings. Both the Ohio Environmental Protection Agency and the Ohio Department of Health have committed to revising their rules regarding well sealing to be consistent with the resulting new technical guidance document. The Well Sealing Workgroup began meeting in July, 1994; what follows is the product of eighteen months of meetings, research, edits, and revisions.

Throughout this document are references to proprietary materials or products. These references should in no way be interpreted as endorsements for any particular brand name or manufacturer, and are used only for illustrative or comparative purposes.

This guidance does not apply to wells constructed for the purpose of injecting fluids into the subsurface (except as it may augment, not supersede, rule requirements). The authority over injection wells depends on the well classification. For more information contact the Ohio Environmental Protection Agency, Division of Drinking and Ground Waters, Underground Injection Control Unit.

Acknowledgements

The preparation of the Technical Guidance for Sealing Unused Wells involved the contribution and hard work of a number of individuals on the Well Sealing Workgroup of the State Coordinating Committee on Ground Water. The development of the Technical Guidance was supported by the State Coordinating Committee on Ground Water and its member agencies. Special appreciation and acknowledgement is given to Katherine Sprowls for her extensive work in organizing, editing and authoring these guidelines. The workgroup also thanks the many industry professionals who graciously took the time to review and provide comments on the guidelines. In addition, the following are deserving of special thanks for the time and effort they devoted to generating the figures found in the guidelines: Janet Welday of the U. S. Geological Survey, Anne Mischo of the Ohio State University Extension, and Wayne Jones and David Orr of the Ohio Department of Natural Resources. Grateful acknowledgement is given to the following workgroup members for their technical research and text authorship, report editing and preparation:

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Ohio Environmental Protection Agency
Ohio Department of Natural Resources
Ohio Department of Health
Ohio Department of Agriculture
Ohio Public Utilities Commission
Ohio Department of Development
Ohio Department of Commerce - State Fire Marshal
Ohio Department of Transportation
United States Geological Survey
Natural Resources Conservation Service

—Rebecca Petty

Introduction

An unused or abandoned water **well**¹ is a well that is no longer in service or is in such a state of disrepair that continued use for the purposes of accessing **ground water** is unsafe or impracticable. Abandoned wells can be found almost anywhere: on farms, industrial sites, and in urban areas. Those marked by windmill towers and old hand pumps are easy to spot. Many lie hidden beneath weeds and brush. These wells are open traps waiting for unsuspecting children, hunters, and animals (Gordon, 1988). In addition, wells are often abandoned when their **yield** has diminished, or the quality of the water they supply has degraded. Each year, many wells are abandoned when homes are connected to community water supplies. No accurate accounting of abandoned wells exists for the State of Ohio. However, it has been estimated that there could be more than 200,000 unused wells in the state (Golden, pers. comm., 1995).

The number of potential contaminants that may enter these wells is unlimited. Fuel, fertilizer, solvents, sewage, animal waste, pesticides and numerous other contaminants have been introduced into ground water through improperly sealed abandoned wells. If a substance can be dissolved, carried, or mixed in water, it has the potential for entering ground water through an improperly sealed abandoned water well (King, 1992).

This guidance outlines the materials and methodologies that should be used to properly seal a well. The intent of this guidance is to provide a comprehensive discussion of all elements involved in the well sealing process, including basic ground water principles and an introduction to well drilling and construction methods. Readers familiar with these topics can move directly to the sections dealing with well sealing procedures, which start on page 20.

In addition, this guidance covers the procedures for sealing **monitoring wells** and **boreholes**. Readers interested in these procedures are probably already conversant with most of the information presented throughout this document. Therefore, the procedures for sealing monitoring wells and boreholes are addressed separately in Appendix 4.

Any well to be abandoned should be sealed to prevent vertical movement of water. The sealing method chosen should be dependent on both well construction and site **geologic/hydrogeologic conditions**. Whenever there is doubt about either the construction of the well or the site hydrogeology, the choices of sealing material and procedure should be those affording the greatest probability of providing a permanent seal.

Overview of Regulations

Current regulations for private (Ohio Administrative Code (OAC) 3701-28-07) and public water wells (OAC 3745-9-10) require that boreholes not converted into wells, and wells not being used to obtain water or provide information on quality, quantity, and water level, be sealed. However, the regulations specify only that the well/**test boring** be completely filled with **grout** in order to seal the **aquifer** and protect the ground water.

The authority for enforcement for public water supplies is the Ohio Environmental Protection Agency (EPA)/Division of Drinking and Ground Waters (DDAGW) Drinking Water Program and the authority for enforcement for private wells is the Ohio Department of Health (ODH) and local health departments.

Proper sealing of all abandoned wells must be documented per the Ohio Revised Code (ORC) Section 1521.05 (B). A well sealing report (Figure A) must be submitted to the Ohio Department of Natural Resources (ODNR), Division of Water. An appropriate form can be requested from the ODNR (614-265-6739). Also, ODH's Private Water Systems Rules require that the local health department be notified when an abandoned well has been sealed. In most counties, sending the local health department a copy of ODNR's well sealing report is an acceptable form of notification.

¹ All terms in bold print can be found in the glossary.

WATER WELL SEALING REPORT
(For Abandoned or Unused Wells)
OHIO DEPARTMENT OF NATURAL RESOURCES
Division of Water, Water Resources Section
1939 Fountain Square Drive
Columbus, Ohio 43224-1360

LOCATION

County DELAWARE Township GENOA Section 4
Property Owner E. J. FUDD
Address of Property 12345 SMOTHERS RD., WESTERVILLE, OH, 43081
Location: 1/2 miles EAST of SUNBURY RD.
n, e, s, w nearest intersection
on the NORTH side of SMOTHERS ROAD
n, e, s, w road
name

ORIGINAL WELL

ODNR Well Log Number N/A Copy attached? Yes or No
(circle one)

MEASURED CONSTRUCTION DETAILS

Date of measurements 8/31/92

Depth of Well 101.5 Static Water Level 14.5
Size of Casing 8 INCH Length of casing ?
Well Condition ABANDONED

SEALING PROCEDURE

Method of Placement PRESSURE GROUT - 1" TREMIE TUBE

			Sealing Material	Volume
Placement:	From <u>101.5</u>	To <u>SURFACE</u>	<u>BENSEAL/E-Z MUD</u>	<u>385 GAL</u>
	From _____	To _____	_____	_____
	From _____	To _____	_____	_____

Was Casing Removed? Yes or No
(circle one)

Condition of Casing GOOD

Perforations: From _____ To _____
From _____ To _____

Date Sealing Performed 8/31/92

Reason(s) for Sealing WELL ABANDONED - NO LONGER NEEDED AND IN THE WAY
OF CONSTRUCTION

CONTRACTOR

Name ACME DRILLING COMPANY ODH Registration # 3456
Address 1234 MAIN ST.
City/State/Zip SOCKERDOWNE, OH, 56789 Signature W.E. Coyote

Reasons to Properly Seal an Unused Well

There are many reasons for properly sealing unused wells. The most important of these include: eliminating physical hazards, preventing ground water contamination, and preventing further loss of confining pressure in **confined aquifers**.

Eliminate Physical Hazard

One of the most obvious reasons to properly seal a well is the physical hazard (Figure B). A good example of this danger was seen a few years ago as the nation witnessed the rescue of a small child from an unsealed abandoned water well that was less than 10 inches in diameter. It is also quite common to find animal remains in unsealed abandoned wells. Other than being the reason for the unfortunate creature's demise, an additional hazard is the possible bacterial contamination of the aquifer caused by the decay of the animal. There also have been cases cited where improperly sealed **geotechnical borings**, used to obtain **stratigraphic** information during highway construction, have caused potholes to occur in newly-constructed highways (Smith, 1994). Geotechnical borings are often drilled on farmland that is in the process of being sold for commercial or industrial use. Imagine the consequences if the farmer's prize-winning Guernsey (or other livestock, for that matter) steps into an open borehole and breaks a leg. These are just a few of the hazards that could result from the existence of unsealed abandoned wells of any type.

Prevent Ground Water Contamination

Another reason to properly seal a well is to prevent ground water contamination (Figure B). There are four ways that an unsealed abandoned well could contaminate the ground water: by intermixing of waters between aquifers, by surface water entering the aquifer, by direct disposal of contaminants down the well, and by bacterial contamination from decomposition of animal bodies and waste products.

Poorly constructed wells or wells that are screened across multiple aquifers can cause intermixing of water between the aquifers. Depending upon the hydrogeologic conditions, poor quality water can move upward or downward into a pristine aquifer. Ground water zones penetrated by a well may have physical or chemical qualities that are incompatible. Chemical reactions may occur that result in undesirable products such as iron sulfides and calcium sulfate (Smith, 1994).

Contaminated surface water can enter a well if the well cap has been broken or removed, or if there are holes in the well **casing** due to damage or deterioration with age. In addition, contaminated surface water can seep down along the space (called the **annular space**) between the casing and the borehole wall of an improperly grouted well. This is an important consideration because most older water wells do not meet today's construction standards.

Illegal direct disposal of contaminants down unused wells is a common occurrence. Open wells offer tempting disposal receptacles for liquid and solid waste. People seem naturally compelled to throw or pour unwanted material down an open hole (Smith, 1994).

Abandoned wells are often preferred havens for a host of arthropods (spiders, earwigs, and centipedes) that prefer dark, moist, calm places. Also these can become subsurface dwellings for rodents and reptiles. The bodies and waste products of these colonists add nutrients and undesirable bacteria to the ground water (Smith, 1994).

Prevent Further Loss of Confining Pressure

It is important to seal a well penetrating a confined aquifer(s) to preserve the confined (or "pressurized") conditions (Figure B). These confining conditions allow the water to reach a certain level in a well (called the **static level**). The static level will be higher than the depth at which the water is encountered in the aquifer; in some cases, the well will flow because the static level is higher than the ground surface. A reduction in the confining pressure may cause water levels in neighboring wells to drop because the **hydraulic head** is no longer high enough to allow the water in these wells to maintain their original static levels. Reduced confining pressures may result from water in a deeper aquifer moving upward into **formations** containing no water, or into **saturated zones** of lower hydraulic head. In the case of flowing wells, the pressure can be reduced simply because of the constant flow of

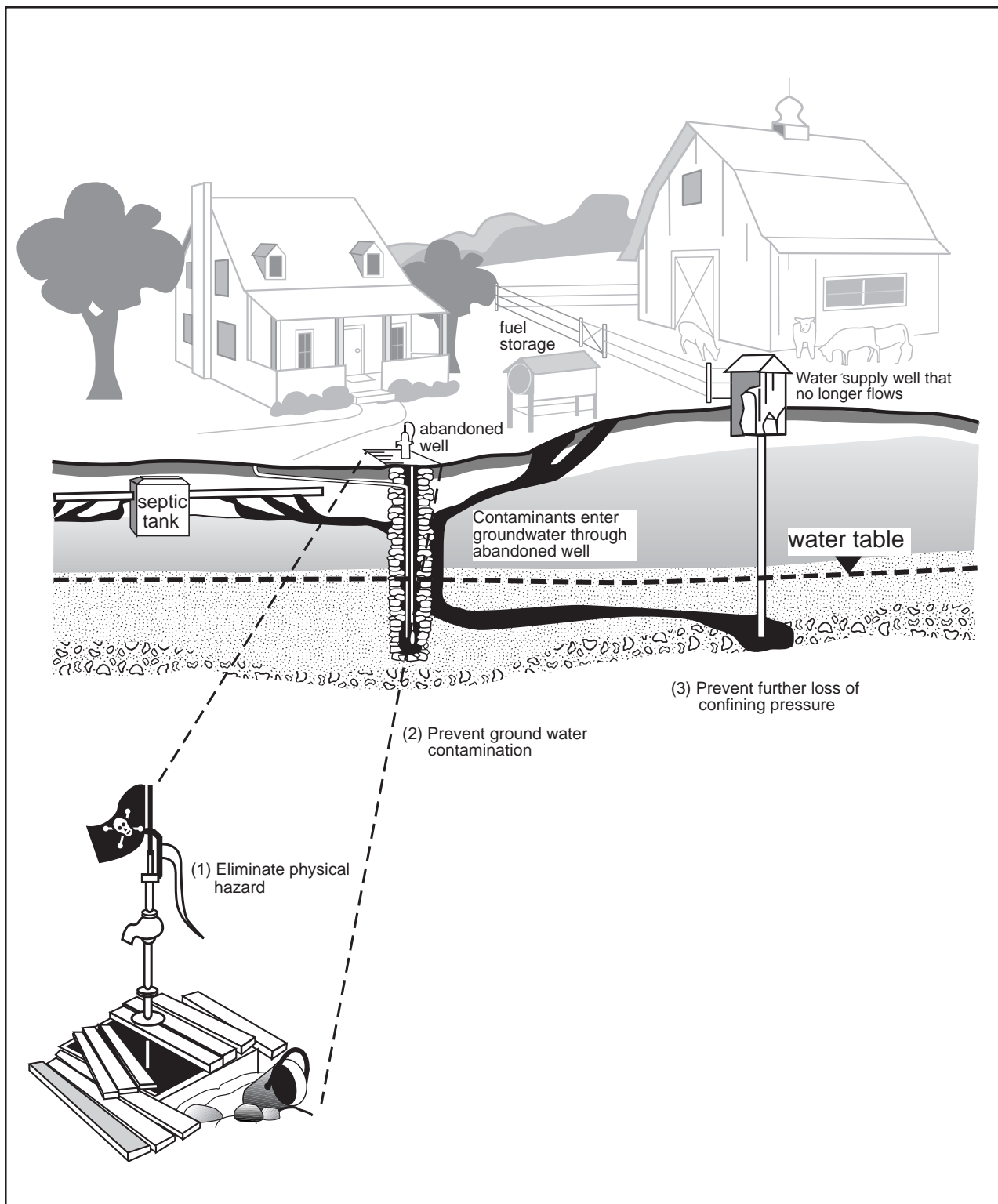


Figure B. Reasons to properly seal an unused well
(After Glanville, 1989, and King, 1992)

water from the aquifer onto the ground surface. Therefore, it is especially important to ensure that abandoned wells penetrating confined aquifers are properly sealed.

Who Should Perform Well Sealing?

It may seem that anyone who can rip open a bag of grout and pour it down the hole could seal a well. However, effective well sealing requires skill and cannot be done carelessly. A sealed-in leaking shaft or hole will most likely result if too little grout is emplaced, or it is mixed improperly, or seals are not set at the right depths, or annulus openings are left outside the casing. The consequence is continued threats to other wells and direct pathways to the ground water (Smith, 1994).

There are no qualifications specified in regulation for persons who can perform well sealing. Based on the difficulty in sealing many wells, and the equipment and knowledge involved, it is strongly recommended that well sealing be completed by an experienced registered drilling contractor. Some work may also need to be supervised by a qualified hydrogeologist or qualified engineer. It should be noted that all professional contractors do not have the same experience. An experienced contractor should be able to provide a description of work to be performed and a list of references proving his/her qualifications. Personnel should be trained and equipped for sites with potential for exposure to contamination or other hazards (Smith, 1994).

In some instances, shallow large diameter **dug wells** can be successfully sealed by a non-professional with minimal amount of special equipment. Be aware, however, that once a well has been sealed improperly, it is costly to correct because the defective seal has to be drilled out. An experienced registered drilling contractor should be consulted, at a minimum, in all sealing situations. It is recommended that wells with one or more of the following characteristics be sealed by an experienced registered drilling contractor only:

- drilled wells,
- flowing wells,
- wells greater than 100 feet in depth,
- wells where water is seeping from around the casing,
- wells where pumping equipment is difficult to remove,
- wells which produce gas, and
- monitoring wells (Zahniser and Gaber, 1993).

Types of Wells Defined by Method of Construction

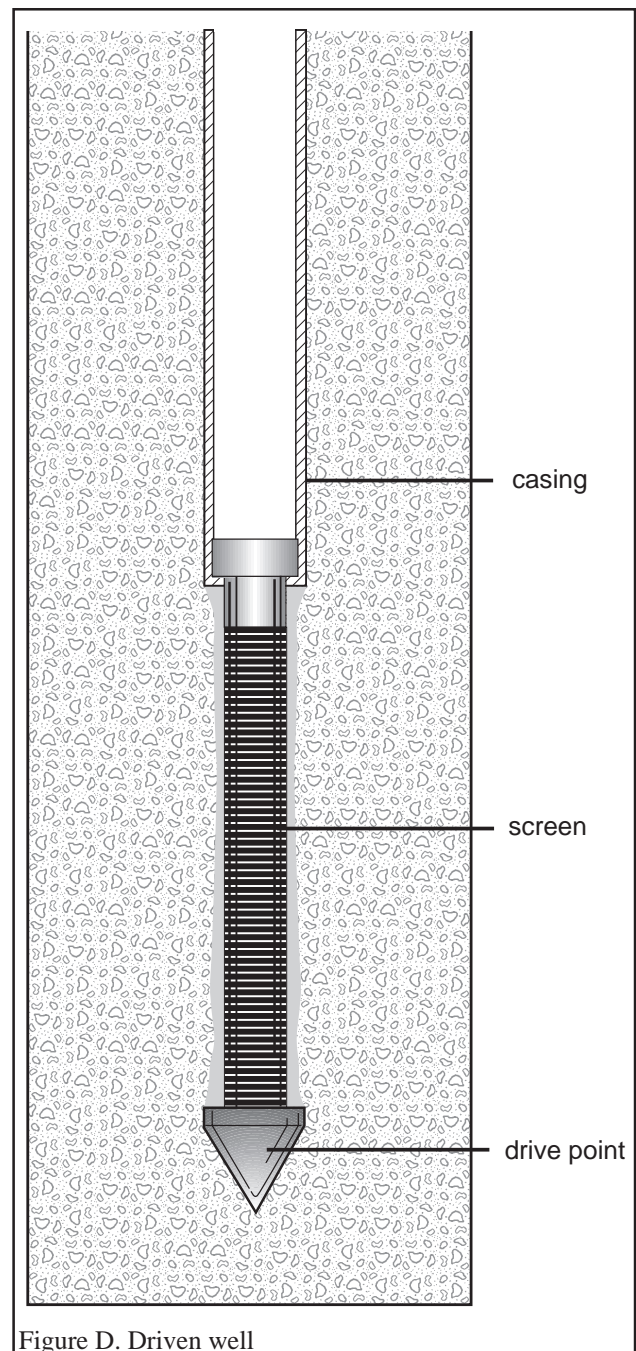
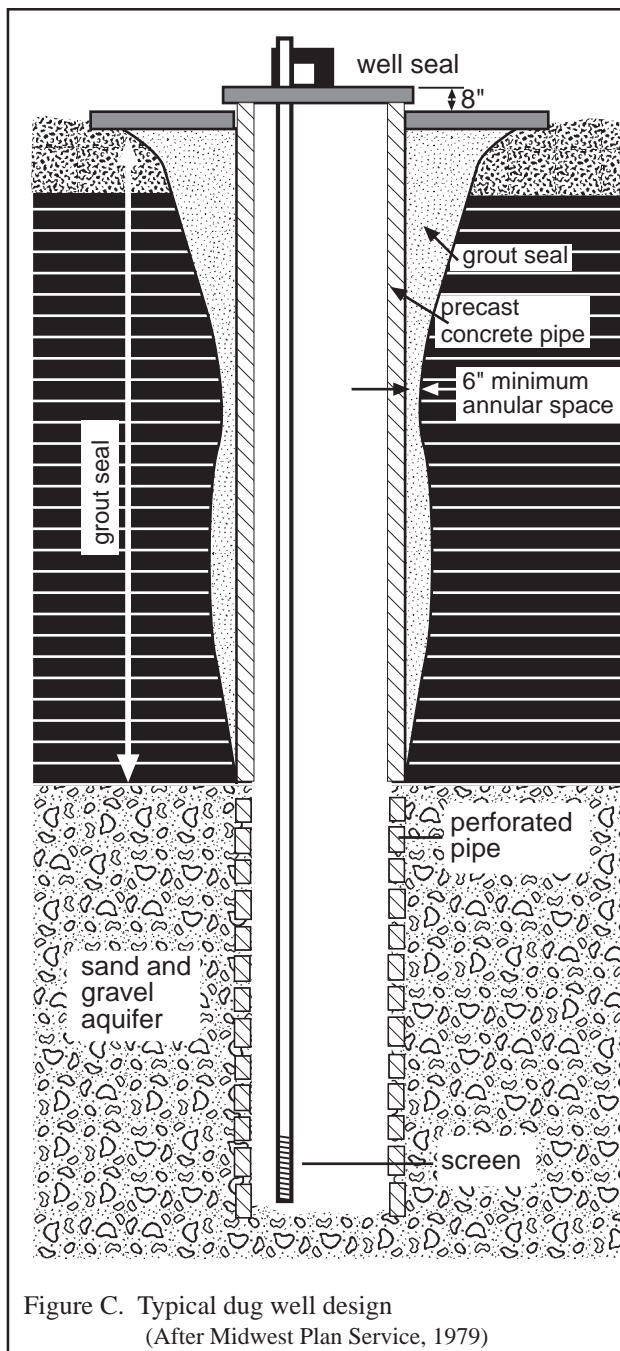
Wells can be described in different ways, either by their method of construction, or by the type of aquifer in which they are developed. To describe wells by their method of construction, it is necessary to understand what it takes to “make a well.” There are three commonly used methods of well construction: digging (by hand or backhoe), driving, and drilling.

Dug Wells

Dug wells can be defined as any wells not installed by drilling rigs. They are usually large diameter (greater than 24 inches) and fairly shallow (25 feet or less, although dug wells deeper than 25 feet are not uncommon), and are constructed by digging with a backhoe or by hand (Figure C). Casing installed in dug wells can vary from concrete pipe and vitrified tile to cobbles and bricks. In some cases, dug wells are improperly used as **cisterns** for roof runoff or hauled water.

Driven Wells

Driven wells, for the purposes of this document, will refer to well points exclusively (Figure D). Well points are installed only in **unconsolidated** formations. Well points are typically small diameter, shallow wells used to supply water for a single household. Many of these wells are installed by the homeowners themselves. Well points consist of a **well screen** with a hardened point which is hammered into place (by hand or machine) using a large weight. Sections of pipe are added to the screen in order to advance the screen to the desired depth.



Drilled Wells

The third major category of well construction methods is that of drilled wells. Drilled wells are those that are constructed using machines designed specifically for the task of well installation. There are several drilling methods commonly used today: boring, cable tool, rotary, and vibratory drilling.

Bored

Bored wells are also known as augered wells and are used to construct wells in unconsolidated formations. There are three principal types of augers used for well drilling: bucket augers, solid-stem augers, and hollow-stem augers. The bucket auger has the largest diameter of the three types of augers, and is the most frequently used augering technique for water supply wells in Ohio. The bucket is cylindrical with hardened teeth on the bottom and has a diameter of 18" to 48". The bucket can remove 24" to 48" of material at a time. Wells drilled with a bucket auger normally range in depth from 50 to 150 feet, but in some areas they can reach 250 feet in depth (Driscoll, 1986). In Ohio, a

bucket-augered well generally is cased with concrete pipe or vitrified tile, and in many respects will resemble a dug well.

Solid-stem augers consist of spiral flanges welded to a pipe. One length of pipe (or auger section) is called a flight; multiple auger sections are often referred to as continuous flighting. The leading auger flight has a special bit or cutter head attached that cuts a hole for the flights to follow. Flights are added as the hole is drilled deeper. **Cuttings** from the drilling process are brought to the surface by the action of the augers (Driscoll, 1986). Boreholes constructed with solid stem augers are typically used for geotechnical, or, less commonly, environmental purposes, rather than water supply wells.

Hollow-stem augers are similar to solid stem augers in design, except that **drill rods** can pass through the auger sections. The leading drill rod has a pilot assembly attached to drill slightly ahead of the lead auger flight (Figure E). The outside diameter of these augers can range from 4 1/4" to 18", with corresponding inside diameters of 2 1/4" to 12 1/4". Because the flights are hollow, they can be used as temporary casing to hold the hole open while the permanent casing is installed. As the well is being installed, the augers are removed. Wells drilled with hollow stem augers have been used to construct water supply wells, but they are more often used to construct monitoring wells.

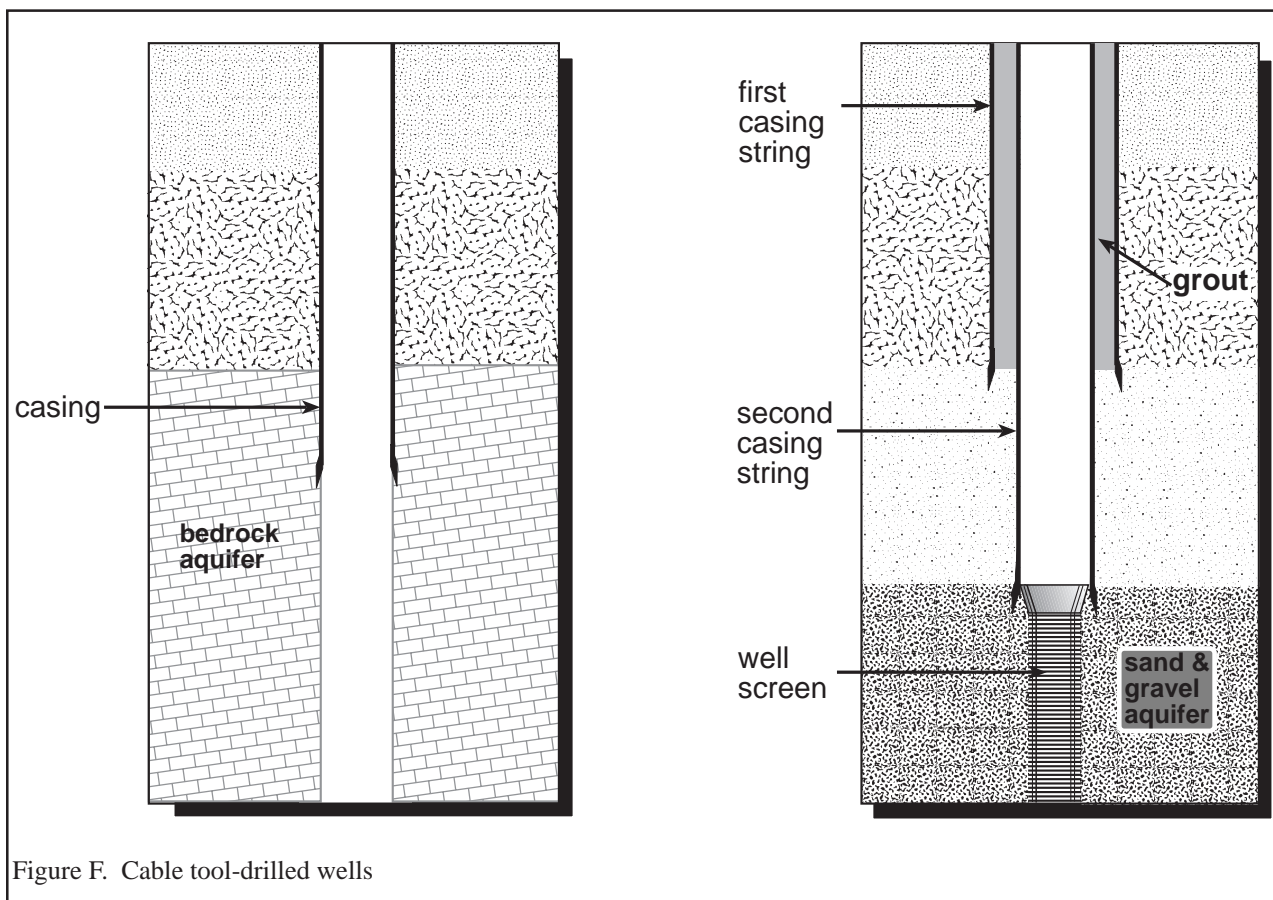
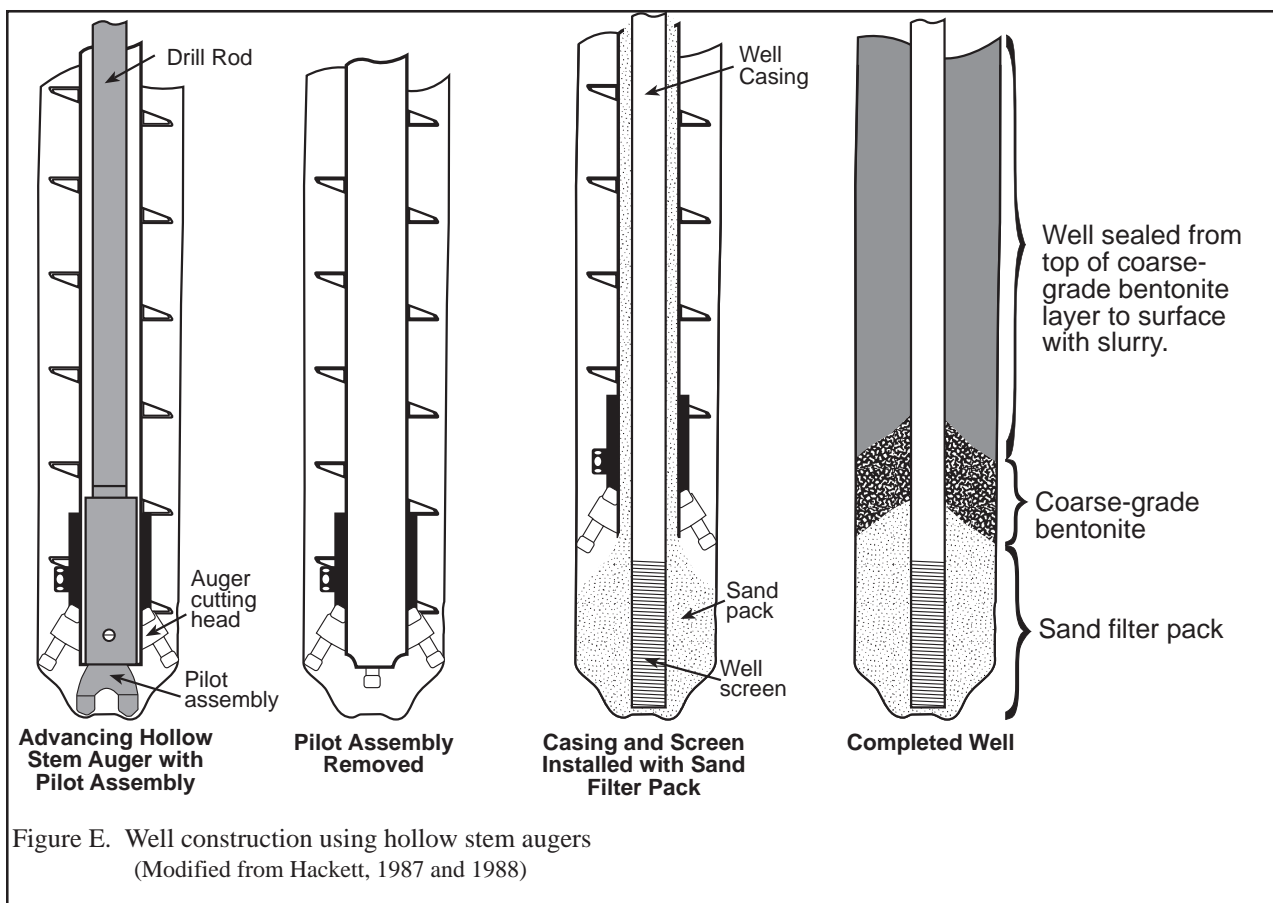
Cable Tool

Cable tool (sometimes called "spudder") rigs operate by repeatedly lifting and dropping a string of **drill tools** into the hole (Figure F). The **drill bit** at the bottom of the drill tools breaks or crushes the formation and when mixed with water forms a slurry. After drilling a certain number of feet, the bit and tools are pulled from the hole and the slurry is removed by **bailing**. In unconsolidated formations, casing is driven into the hole behind the drill bit so that the hole will stay open. When the desired depth has been reached, the casing can be pulled back to expose a screen, if one is to be installed. In some cases, drilling a well deep into unconsolidated sediments requires that two strings of casing be used; that is, the driller will start with a particular diameter casing, then when this size casing can no longer be driven, a smaller diameter casing is set inside the larger casing and the drilling and driving process continues until the well is completed. This technique works because the smaller diameter casing has less friction working against it. However, when drilling a well into the bedrock with a cable tool rig, usually a single casing string is set a few feet into the bedrock, and drilling continues open hole until the desired depth is reached. Cable tool drilling is still the most commonly used method of drilling water wells in Ohio. About 79 percent of the drilling contractors operating in the state of Ohio own cable tool rigs.

Rotary

Rotary rigs use one of two methods to rotate the drill bit: a table drive or top head drive. The rotation of the table or top head is transferred to the drill rods, which in turn rotate the bit. Mud rotary rigs use a roller cone bit at the end of the drill rods. The drill cuttings are circulated out of the hole with water or **drilling mud**. When the appropriate depth has been reached, the drill rods are withdrawn from the hole. The casing and screen (if needed) can then be set in the open borehole. Since it is necessary to drill an oversized borehole with this type of drilling method, the outside diameter of the well casing will be at least 2" smaller than the diameter of the borehole. Therefore, it is important that the space between the casing and borehole wall (annular space) be sealed to prevent contamination from the surface, and to hold the casing in place in the borehole.

Air rotary drilling rigs operate in basically the same way as mud rotary. However, instead of using drilling mud to clean the cuttings out of the borehole, a combination of compressed air and water is used. Air rotary rigs also run roller cone bits, but, in addition, they have the capability to run a down-the-hole hammer. The down-the-hole hammer is used for **consolidated** formations only. Compressed air is forced down the drill rods to operate the piston-like action of the hammer (bit). The hammer pulverizes the material being drilled. The air, in combination with water or foam, lifts the cuttings out of the hole. Hole sizes can range from 4 1/8" to 30" (Ingersoll-Rand Co., 1988). Usually a well will be drilled with mud through unconsolidated formations to the bedrock formation, if that is the aquifer. After the casing is set and grouted into place, the well can continue to be drilled with a combination of air and water until the desired depth is reached. Both methods of rotary drilling are frequently used in Ohio to construct water supply wells. Figure G shows typical rotary-drilled well construction.



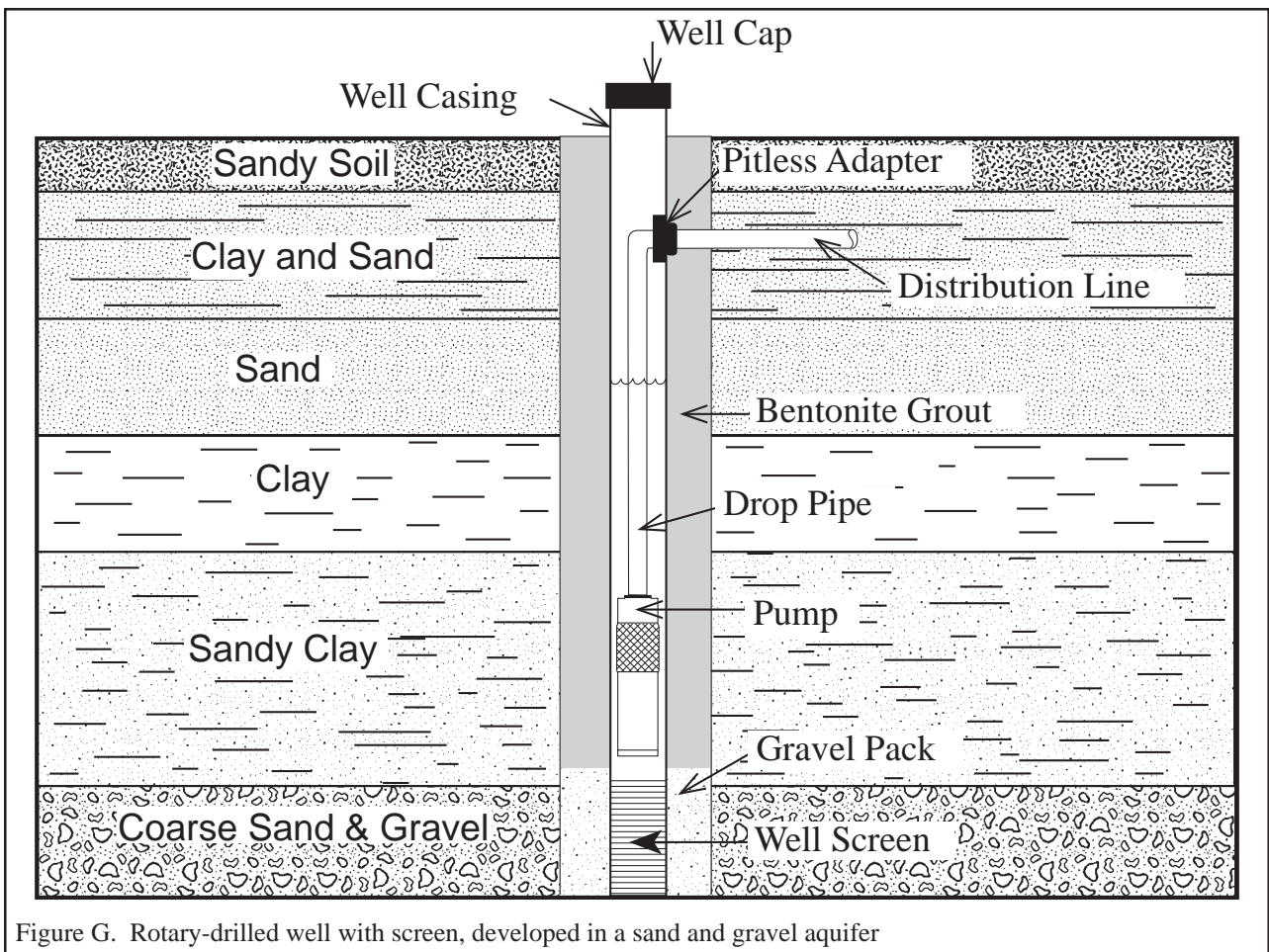


Figure G. Rotary-drilled well with screen, developed in a sand and gravel aquifer

Another method of rotary drilling is reverse rotary. Reverse rotary drilling is most often used to construct large diameter (24 inches or greater) water supply wells. Reverse rotary rigs are similar to air or mud rotaries in design, but are larger in size. The bit is rotated by table drive exclusively, as the top head drive does not develop enough torque to turn the size of the bit required to drill large diameter wells. The major difference between the reverse rotary and the other rotary methods described here is the pattern of fluid circulation. With reverse rotary, the drilling fluid is added to the borehole through the annular space, then the fluid and cuttings are removed from the hole by suction through the drill rods. The fluid and cuttings are deposited into a mud pit, where the cuttings settle out and the fluid is recirculated. The resulting large-diameter borehole allows easy installation of **filter pack** and well screens, which are necessary to properly develop high capacity wells in unconsolidated formations. Reverse rotary drilling can also be used in most consolidated formations (Driscoll, 1986).

Vibratory

Vibratory drilling involves the use of a resonance source through the drill rods to drill a hole to the desired depth. The resonance through the casing (rods in this case) pushes the cuttings into the side wall of the hole and into the center of the pipe. This method produces a minimal amount of cuttings, uses no drilling mud, and produces a continuous core. This drilling method is used mostly for geotechnical and environmental sampling purposes. Monitoring wells can be set through the casing if desired.

Types of Wells Defined by Aquifer Characteristics

Wells can be described by the types of aquifers in which they are developed. An aquifer is a geologic formation, group of formations, or part of a formation that is capable of yielding water to a well or spring. Figure H shows the statewide distribution of expected well yields from aquifers (this map is very general and should not be used to determine well yields on a site-specific basis). These

yields, are directly related to the types of geologic formations that comprise the aquifers. For example, the white areas on the map signify aquifers that typically yield less than five gallons per minute to a well. The aquifers in these areas generally consist of shales, or interbedded limestone and shale, or, in some cases, interbedded shale, limestone, and sandstone.

Geologic formations in Ohio will be either consolidated or unconsolidated. Consolidated formations are those that are lithified, that is, hardened into rock. A borehole penetrating a consolidated formation would be able to stay open indefinitely without the benefit of casing. Consolidated aquifers in Ohio generally consist of sandstone, limestone, or shale. The most productive consolidated aquifer is cavernous limestone. Sealing wells that penetrate fractured and cavernous rock may have special problems due to loss of grouting material.

Unconsolidated formations are usually soft and loose (there are some exceptions). Wells penetrating unconsolidated formations must be cased, otherwise the borehole walls will collapse. Unconsolidated aquifers in Ohio consist of silt, sand, gravel, or any combination of the three. Many of the state's most prolific wells are developed in sand and gravel aquifers.

Consolidated and unconsolidated aquifers can also be confined or unconfined. Unconfined aquifers are aquifers in which there are no **confining beds** between the zone of saturation and the surface (see Figure I for example). They are often referred to as water table aquifers. The upper surface of

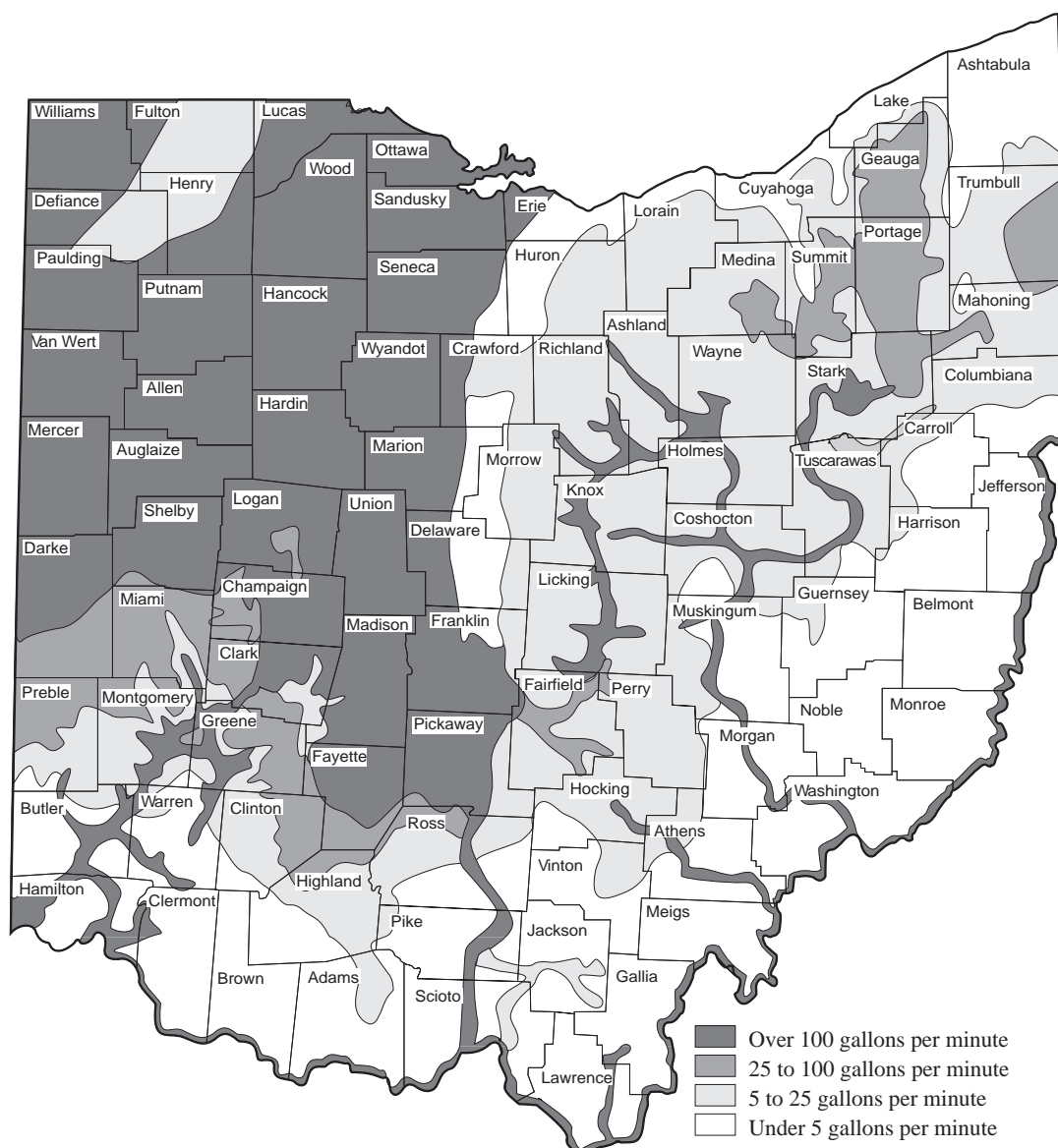


Figure H. Generalized map of ground water resources in Ohio

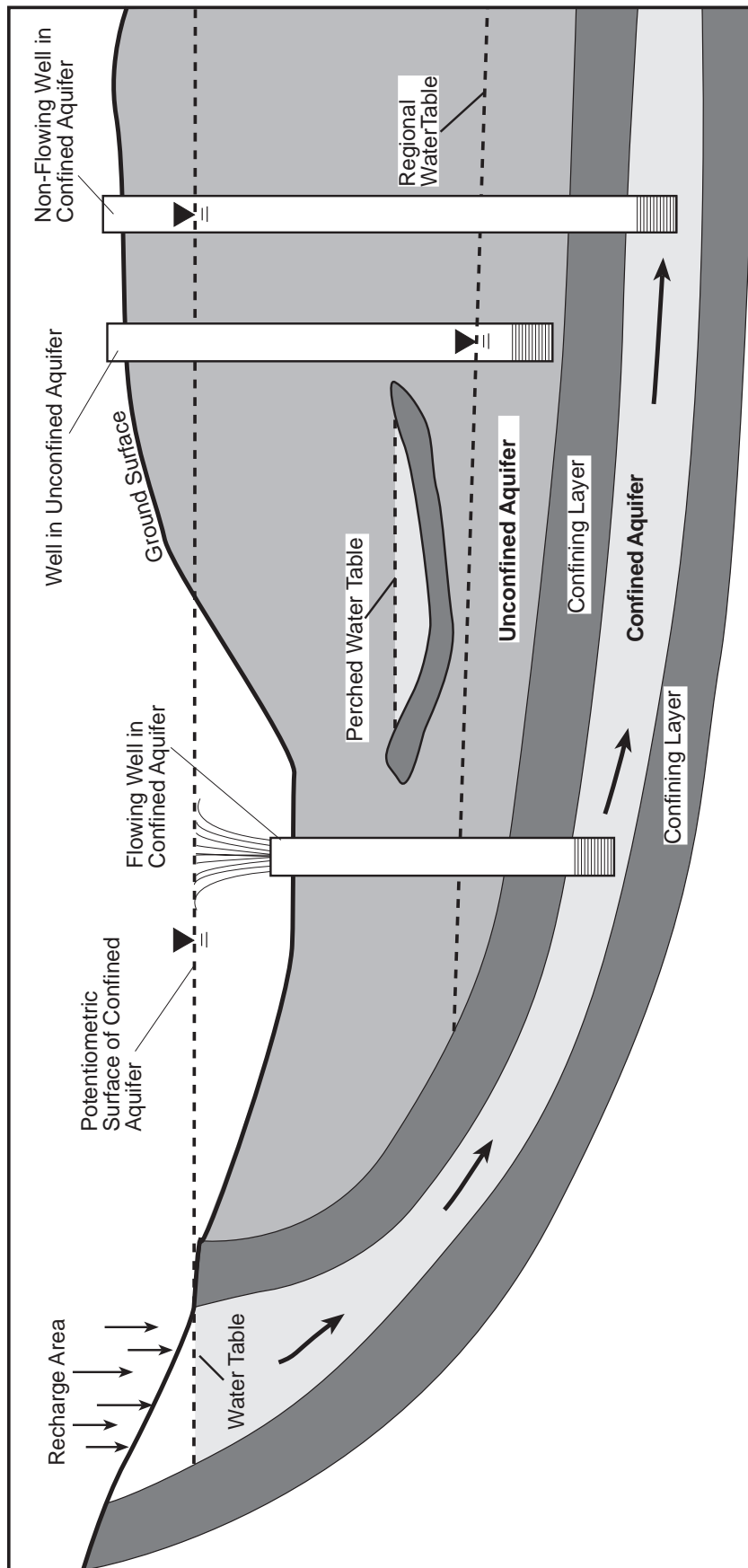


Figure I. Confined and unconfined aquifers
(After U. S. Department of the Interior, 1977)

an unconfined aquifer is in direct contact with the atmosphere through open **pores** of the material above and is everywhere in balance with the hydraulic head in the **recharge** area. Therefore, the static level in a well penetrating an unconfined aquifer will be the same as the level of the water table. Confined aquifers are aquifers that are overlain by a confining bed (see Figure I also). The confining bed has a significantly lower **permeability** than the aquifer. When a confined aquifer is penetrated by a well, the water will rise above the confining unit to an elevation that is equivalent to the hydraulic head of the confined aquifer. If this elevation is greater than the top of the well, the water will flow from the well (commonly called an artesian well). The term artesian well, however, includes any well developed in a confined aquifer where the water level rises above the top of the aquifer, not just those that are flowing.

Wells developed in confined aquifers can present a special problem when it comes time to seal them. Also, wells screened across several aquifers will require more care in sealing. These wells must be sealed in such a manner so that there is no intermixing of water between the aquifers. In addition, careful consideration must be given to choosing an appropriate sealing method for wells screened in a single aquifer but penetrating several aquifers. These scenarios and others will be addressed in the section on **Procedures For Sealing The Well**.

Preparation for Sealing

Well Information

Information concerning the geology and physical condition of the well, such as total depth, formations encountered, and diameter are important in determining the sealing method. Geologic conditions vary throughout the state and different methods of sealing are needed to meet these varying conditions. Well construction details are needed to determine the type and amount of materials needed to seal the well.

The best source of information is the “Well Log and Drilling Report” that is completed by the driller at the time of construction. These logs contain well construction information and a record of formations encountered during well installation. Figure J is an example of a well log. An accurate well log will enable a drilling contractor to select the most appropriate sealing method for that well. Copies of these reports are filed with the Ohio Department of Natural Resources, Division of Water, and, within the last 10 to 15 years, each county health department. To obtain a copy of a well log and drilling report, it is necessary to know the county in which the well was drilled, the township within that county, the street address, the name of the property owner at the time the well was drilled, the names of the nearest cross roads, and the approximate year in which the well was drilled. It may not be possible to discover all of this information, but the Division of Water will do a file search with the information that is available. Occasionally, a well log and drilling report may not be on file, either because the well was drilled before the filing law went into effect (1947) or because, for some reason, the log was not sent to the Division. Call the Division of Water, Water Resources Section at 614-265-6740 to have the files searched for a specific well log and drilling report.

Logs for nearby wells should be reviewed if a well log and drilling report cannot be located. Often, wells on adjacent properties will be of similar depths and construction. If a well is free of obstructions (including old pumps), then the depth may be easily determined with a weighted measuring tape or rope. Local drilling contractors will also be familiar with the general geologic conditions in the area.

Other methods for examining the condition of a well include casing-depth indicators, borehole video cameras, and geophysical logging equipment such as calipers and gamma-ray probes. These tools are commonly used in the maintenance of public supply wells and in scientific investigations. These methods are likely to be expensive, but most wells will not need such detailed investigations. Local drilling contractors should be able to locate firms possessing this equipment, if necessary.

Casing Issues

Well casing is usually constructed of plastic (PVC), steel (in drilled wells), or concrete pipe, vitrified tile, brick, or cobbles (in dug wells). The well screen is a section of wire-wrapped or machine-slotted casing through which water enters the well. In many older wells, it was common

practice to cut slots with a torch in the bottom two or three feet of casing to produce a home-made screen. These types of “screens”, however, are highly inefficient and susceptible to corrosion and plugging. The casing and screen prevent the surrounding formations from caving into the well. Some formations are sufficiently consolidated that the well will remain open and no well screen is required.

Water can migrate along the space between the casing and the borehole wall; therefore, the best way to seal a well is to remove the casing and screen (if any), and grout the open hole. If there is no well log or other information about the construction of the well, or if the well casing is in poor condition, then it is probably best not to remove the casing (unless the well is an environmental well that can be easily overdrilled). Consideration should be given to having a registered drilling contractor rip or perforate the casing in such cases.

Sealing Materials

The data in this section relies heavily on information found in the Michigan Water Well Grouting Manual (Gaber and Fisher, 1988).

Materials used for sealing abandoned water wells must have certain properties to make them desirable for use. The ideal grout should 1) be of low permeability in order to resist flow through them, 2) be capable of bonding to both the well casing (if necessary) and borehole wall to provide a tight seal, 3) be chemically inert or nonreactive with formation materials or constituents of the ground water with which the grout may come in contact, 4) be easily mixed, 5) be of a consistency that will allow the grout to be pumped and remain in a pumpable state for an adequate period of time, 6) be capable of placement into the well through a 1-inch diameter pipe, 7) be self-leveling in the well, 8) have minimal penetration into permeable zones, 9) be capable of being easily cleaned from mixing and pumping equipment, 10) be readily available at a reasonable cost, and 11) be safe to handle.

Grouting materials currently used in water wells are comprised of either cement or bentonite. Although there are advantages and disadvantages with each material and none of the grout materials available today exhibit all of the desirable characteristics listed above, field experience has shown each to be suitable under most geological conditions. Table 1 lists advantages and disadvantages of cement and bentonite grouts.

Final permeability of the grout is recommended to be 1×10^{-7} centimeters per second to retard fluid movement. Table 2 shows approximate permeability values for various sealing materials.

Cement-Based Grouts

Cement Properties

Portland cement is the main ingredient in cement-based grouts such as neat cement or concrete. Cement is a mixture of lime, iron, silica, alumina, and magnesia components. The raw materials are combined and heated to produce cement clinker. The clinker is ground up and mixed with a small amount of gypsum or anhydride to control setting time.

When Portland cement is mixed with water (producing neat cement), several chemical reactions occur. Heat is generated as the mixture cures and changes from a slurry to a solid. This is referred to as the heat of hydration and results in a temperature increase in the formation material at the cement/borehole interface and the well casing, if any remains in the hole (Troxell, et.al., 1968; Portland Cement Association, 1979). The amount of heat given off is dependent upon several factors such as cement composition, use of additives, and surrounding temperatures. Excessive heat of hydration may adversely affect the structural properties of any PVC plastic well casing left in the borehole (Molz and Kurt, 1979; Johnson et.al., 1980).

The setting of cement is controlled by temperature, pressure, water loss, water quality, and other factors (Smith, 1976). Warm water used for slurry preparation and warmer air temperature will cause faster setting than cold water and cooler air temperature. Cement in the borehole will tend to set faster at the bottom since the weight of the cement column will increase hydrostatic pressure on the cement at the bottom. Water expelled from the cement into permeable zones will also result in an increased rate of setting. Standard Portland cement will reach its initial set in about 4 hours at a 50°F curing temperature. Table 3 shows total curing times for various cement grouts.

Table 1
Grout Properties

CEMENT-BASED GROUTS	Advantages	Disadvantages
	Suitable Permeability	Shrinkage & Settling
	Easily Mixed & Pumped	Long Curing Time
	Hard-Positive Seal	High Density Results in Loss To Formations
	Supports Casing	Heat of Hydration
	Suitable For Most Formations	Affects Water Quality
	Proven Effective Over Decades Of Field Use	Equipment Clean-Up Essential
	Properties Can Be Altered With Additives	Casing Cannot Be Moved After Grouting
BENTONITE-BASED GROUTS	Suitable Permeability With High Solids Grouts	Premature Swelling And High Viscosity Result in Difficult Pumping
	Non-Shrinking & Self-Healing	Difficult Mixing
	No Heat of Hydration	Subject to Wash Out in Fractured Bedrock
	Low Density	Subject to Failure From Contaminated Water
	No Curing Time Required	Equipment Clean-Up Difficult
	Casing Movable After Grouting	Limited Field Experience
		Usage Instructions Vary For Each Product
		Limited Availability

Table 2
Permeability of Various Sealing Materials

Sealing Material	Permeability (K) in cm/sec
Neat Cement (6 gal water/94 lb sack)	10^{-7}
Bentonite Grout (20% Bentonite)	10^{-8}
Bentonite Pellets	10^{-8}
Granular Bentonite	10^{-7}
Granular Bentonite/Polymer Slurry (15% Bentonite)	10^{-8}
Coarse Grade Bentonite	10^{-8}
(From American Colloid Co, and N.L. Baroid/N.L. Industries, 1989)	

Table 3
Cement Curing Time Required

Grout Type	Curing Time
Neat Cement - Type I	48 Hours
Concrete Grout - Type I	48 Hours
Neat Cement w/2% CaCl_2	24 Hours
Hi-Early Cement - Type III	12 Hours
Concrete Grout - Type III	12 Hours

Cement Types

Several types of cement are manufactured to accommodate various chemical and physical conditions which may be encountered. The American Society for Testing and Materials (ASTM) Specifications C150 (ASTM, 1992) is the standard used by cement manufacturers.

Portland cement Types I and IA are readily available throughout Ohio. Type II cement is available at some of the larger building supply outlets. Other cements are available by special order through cement suppliers. The different types of cement and their appropriate usage are described as follows:

- Type I — General purpose cement suitable where special properties are not required.
- Type II — Moderate sulfate resistance. Lower heat of hydration than Type I. Recommended for use where sulfate levels in ground water are between 150 and 1500 ppm.
- Type III — High-early-strength. Ground to finer particle size which increases surface area and provides faster curing rate (approximately $\frac{1}{4}$ of the time it takes for Type I to cure). When Type III cement is used, the water to cement ratio must be increased to 6.3 to 7 gallons of water per sack.
- Type IV — Low heat of hydration cement designed for applications where the rate and amount of heat generated by the cement must be kept to a minimum. Develops strength at a slower rate than Type I.
- Type V — Sulfate-resistant cement for use where ground water has a high sulfate content. Recommended for use where sulfate levels in ground water exceed 1500 ppm.

Expansive-type cements are also available in Ohio. This type of cement will expand upon curing by use of additives in the mix, such as gypsum or aluminum powder.

Neat Cement Grout

Neat cement slurry is comprised of Portland cement and fresh water, with no aggregate present. It was first used as a grouting material in Texas and Oklahoma oil fields in the early 1900's (Smith 1976). Neat cement has since been used extensively in both the oil & gas and water well industries. Field experience has shown it to be effective for sealing off formations when properly applied. It can be mixed using a wide variety of methods. Generally, lower pressures are developed while pumping neat cement grouts. The main disadvantages of using neat cement are shrinkage upon curing, possible formation of a **microannulus** around the casing, and, in some cases, mixing according to manufacturer's specifications, which can result in a thick mixture that is difficult to pump.

In some states, neat cement is considered superior to bentonite-based grouts in situations where bedrock is encountered within 25 feet of ground surface. This is because it will form a hard, rock-like seal consistent with the bedrock and will not wash out or dilute from higher ground water flow rates encountered in some highly fractured formations.

The amount of shrinkage or settling, and compressive strength, of neat cement is dependent upon the proportion of water to cement in the slurry (Coleman and Corrigan, 1941; Halliburton Services, 1981). As the water to cement ratio increases, the compressive strength of the neat cement will decrease and shrinkage will increase. Laboratory studies and field experience have demonstrated that settling of cement particles will occur, resulting in a drop in the grout level (Coleman and Corrigan, 1941, Kurt, 1983). The top of the hardened neat cement grout mass will generally be a few feet below the slurry level due to this settling. Field observations show that the amount of settling will usually be 5 to 10 percent of the total grouted depth if the neat cement is mixed at 5 to 6 gallons of water per sack.

The American Petroleum Institute (API) recommends a water to cement ratio of 0.46 by weight or 5.2 gallons of water per 94-lb sack of cement. This is the amount of water needed to hydrate the cement. More than 5.2 gallons/sack ratio will thin the grout and make it easier to pump, but will adversely affect the grout's sealing properties. This guideline recommends that the maximum amount of water mixed per sack of cement be 6 gallons. The neat cement slurry at 6 gallons of water per sack of cement should weigh a minimum of 15 lbs/gal before pumping. At weights greater than 16 lbs/gal, pumping of the slurry becomes difficult due to higher **viscosity** and pumping pressure. **Density** measurements of the slurry using a **mud balance** are recommended to assure proper water-to-cement ratios.

Under certain conditions it may be necessary for the consulting engineer or regulatory agency to specify an increase in the water to cement ratio. Factors such as the cement type, addition of additives, and quality of ground water will affect the grout performance and should be considered when planning the grouting operation.

Concrete Grout

Concrete grout consists of Portland cement, sand, and water. The addition of sand to a neat cement slurry results in less shrinkage and tighter bonding to the casing and borehole. Also, the sand in the slurry will aid in bridging pores in permeable formations. Concrete grout should be used only under specific sealing circumstances, such as for sealing flowing wells, sealing water wells with natural gas or methane present, and sealing wells with cavernous zones. Concrete should be handled only by experienced registered drilling contractors due to the exacting requirements for its successful installation. Concrete grout must be pumped down a tremie pipe, or, if the borehole is free of water, poured down. Placing concrete grout through a column of water will cause the separation of sand from the slurry and result in placement problems. If concrete grout is used on a routine basis, it should be pumped through a metallic grout pipe because it is highly abrasive on plastic pipe. Concrete grout can also cause excessive pump wear.

Other Cement Additives

Accelerators may be added to cement to decrease its setting time when attempting to cement off flows in and around casings. This will allow the cement to set before it is washed out of the hole. Calcium chloride is the most common and readily available accelerator. It is generally used at between 2 and 4 percent by weight of cement. Accelerators should be used with caution since miscalculations or equipment breakdown can result in a cemented grout pump or hose. Other additives such as retarders, weight-reducing agents, weighting agents, lost circulation control agents, and water reducing agents are available for cements but are not routinely used for water well sealing.

Bentonite—Based Grouts

Clay Properties

Clays are the principal ingredient of all bentonite-based grouts and drilling muds. They may be characterized as naturally occurring substances which exhibit colloidal-like properties (remain in suspension in water for a long period of time) and varying degrees of **plasticity** when wet (Bates, 1969). The term clay is frequently applied to a variety of fine-grained materials including clays, shales, and clayey soils. They are all composed of small crystalline particles which are known as the clay minerals.

The common characteristic associated with clays is the very small particle size that has a very high surface area to mass ratio. Negative electrical charges on the particle surface result in the interaction of clays with other particles and water. This, coupled with the ability of certain clays to swell many times their original volume when **hydrated**, accounts for many of the properties and uses for clays.

The variety of bentonite commonly used in grouting materials and drilling muds is one in which the clay mineral is predominantly sodium-rich montmorillonite. Mined at relatively few locations, the majority of the high-grade sodium bentonite is obtained in Wyoming, Montana, and South Dakota (Gray and Darley, 1981). These clays are characterized by their ability to absorb large quantities of water and swell 10 to 12 times in volume. Bentonite particles tend to remain in suspension an indefinite period of time when placed in water. The resulting slurry is of low density and high viscosity. Bentonites that have calcium as the predominant exchangeable ion are less desirable as sealing materials because they have significantly lower swelling ability (Gaber and Fisher, 1988). That is why mixing cement and bentonite is ineffective for preventing shrinkage of cement as it cures. Calcium ions in the cement replace sodium ions in the bentonite by a process called ion exchange. The resulting calcium bentonite has little or no swelling capability, and is therefore unable to prevent shrinkage of the cement (Smith, 1994).

Properties of Bentonite/Water Slurries

Three important physical properties of a water/bentonite slurry are: 1) density, 2) viscosity, and 3) gel strength. A review of these properties will aid in understanding what makes a good bentonite grout.

Density is defined as the weight per unit volume of a fluid and is commonly expressed in pounds per gallon. The terms weight and density, although technically distinct, are frequently used interchangeably in the drilling industry. The density of grout determines how much pressure is exerted on the formation when the fluid is at rest and is a direct indicator of the amount of clay solids present. The higher the density, the more solids are suspended in solution. Density is measured using a mud balance. A mud balance measures a specific volume of grout slurry in pounds per gallon. The densities of various sealing materials can be seen in Table 4.

Measurements should be taken after each grout batch is mixed and a grout sample should also be collected after the grout appears at the surface. The grout discharged from the well should have a density equal to that of the grout before it was pumped. The grout must be pumped into the well until dilution is minimal.

Viscosity is a measure of a fluid's resistance to flow. The higher the viscosity of a fluid, the more difficult it becomes to pump. The viscosity of bentonite-based grouts is dependent upon a number of factors including: 1) the density, 2) the size and shape of the clay particles, and 3) the charge interaction between the particles (Driscoll, 1986). Viscosity can be measured with a Marsh funnel viscometer, which determines the time it takes to dispense one quart of fluid through the funnel. Water has a Marsh funnel viscosity of approximately 26 seconds; bentonite-based grouts should have a 70 second viscosity. Grout should be periodically checked for adequate viscosity. A low viscosity grout will make a less effective seal than a grout with the proper viscosity.

Gel strength is a measure of internal structural strength. It is an indication of a fluid's ability to support suspended particles when the fluid is at rest. Gel strength is caused by the physical alignment of positive and negative charges on the surface of the clay particles in solution. Gel strength is responsible for the quasi-solid (plastic) form of a clay/water mixture.

Table 4
Grout Slurry Densities

Product	Water Ratio	Minimum Density Lbs/Gal	Volume ft ³ /sack
Neat Cement	6.0 gal./sack of cement	15.0	1.28*
	5.2 gal. recommended/sack of cement	15.6	1.18*
Neat Cement & CaC1 (accelerator)	6.0 gal./sack of cement CaC1- 2 to 4 lbs. sack of cement	15.0	1.28
Concrete Grout	1 sack of cement and an equal volume of sand per 6 gallon maximum water	17.5	2.0
Bentonite			
Benseal/EZ-Mud	Benseal - 1.5 pounds/gallon of water EZ-Mud - 1 quart/100 gallons of water	9.25	4.75
Volclay	2.1 pounds/gallon of water	9.4	3.6
(*From Halliburton Services, 1981)			

The gel strength is affected by how well the clay particles are dispersed in solution and the amount of water the particles have absorbed. Gel strength is not typically measured in the field. However, it is related to the fluid density and is dependent largely on the quality of the bentonite.

High-Solids Bentonite Grout

Within the last decade, bentonite products developed specifically for well grouting have appeared on the market. Some use chemical additives when mixing to control the development of viscosity and gel strength. By design, these products are meant to be easy to pump, place, and clean up. Premature swelling and/or high viscosities may make them difficult to pump when they are not mixed properly. Generally, bentonite grouts require higher pumping pressures than neat cement grouts (Gaber and Fisher, 1988). It also is important to know the environment into which the bentonite will be placed.

For example, high concentrations of chlorides in the water will suppress the hydration of bentonite unless it has been mixed with an agent that counteracts the effect of the chlorides (Smith, 1994).

The bentonite-based grouts currently available can be broadly grouped into four classifications. The classifications reflect the degree of processing and the particle size of the bentonite constituent. The four classes of materials are: 1) powdered bentonite, 2) granular bentonite, 3) coarse grade bentonite, and 4) pelletized bentonite. Each class of bentonite requires a different handling and placement method. Manufacturers recommend that mixing and placement methods should be assessed with regard to the depth to the water table, the required depth of grouting, and other pertinent geological information.

Powdered Bentonite/Clay Grout

Powdered bentonite/clay products available are similar in texture, appearance, and packaging to the high yield drilling mud grade bentonite. They are a mixture of bentonite clays (sodium and calcium) and other clays and do not possess the expansion characteristics of grouts containing predominantly sodium bentonite. They are marked as high solids clay grout with a resulting slurry of 15 to 20 percent clay solids by weight of water and are designed to have extended workability. When properly applied, they result in a flexible seal of low permeability. Adequate mixing of this product requires the use of a venturi-type mixer and a mud rotary type mud pump and recirculation system or a paddle mixer.

Some products utilize an inorganic chemical additive (magnesium oxide) referred to as an initiator, to aid in the development of gel strength. Exclusion of the initiator can result in decreased set strength, affecting the quality of the seal. Failure to meet manufacturer's density requirements or placement of the grout on top of a lower density material (e.g., drilling mud or water) can result in a disappearance of the grout material from the well. This is due to a lack of gel strength development, resulting in settling of bentonite material in the well or loss to surrounding formations. For this reason, the use of these products requires placement of the material the entire length of the borehole. A bentonite pellet or neat cement cap a few feet thick is also recommended near the surface.

Granular Bentonite Slurries

Granular bentonites are generally manufactured from high-yield, non-drilling grade bentonite. The bentonite is processed to provide coarse granular particles (predominantly 8 to 20 mesh) which possess considerably lower surface area-to-mass ratios than the finely ground, powdered bentonite. This results in slower water absorption and delayed hydration and expansion when compared to a finely ground bentonite.

One advantage of the granular bentonite slurry is that the delay in swelling of the bentonite particles for a short period of time (15 minutes or less) allows preparation of a slurry possessing a lower viscosity. If mixing and pumping are done efficiently, the granular bentonite slurries allow placement of a high density grout in a low viscosity state. Expansion of the bentonite then occurs downhole. Granular bentonite may be prepared with 15 to 20 percent bentonite content by weight. This results in a set grout which exhibits excellent permeability and gel strength characteristics.

These products rely on the addition of a synthetic organic polyacrylamide polymer to suppress the hydration and delay swelling of the bentonite particles. The use of such products requires particular attention to the manufacturer's mixing recommendations. One recommended mixing procedure requires addition of the polymer to water at a rate of 1 quart of polymer per 100 gallons of water prior to adding the granular bentonite at 1-1/2 to 2 lbs. per gallon (Smith and Mason, 1985). Mixing requires the use of blade or paddle-type mixers or grout mixers with recirculation. Centrifugal pumps are not recommended for mixing or pumping granular bentonite slurries. Upon addition of the bentonite, pumping of the grout material must be accomplished before swelling of the bentonite occurs. If expansion occurs prematurely the slurry cannot be pumped and the batch is wasted.

Coarse Grade Bentonite

Coarse grade bentonite, also referred to as crushed or chip bentonite, is processed by the manufacturer to provide a large particle size and density. The bentonite particles are sized from 3/8 to 3/4 inch

and are intended to fall without bridging through a column of water in a borehole. When placed properly, the coarse grade bentonite provides a high density, flexible down-hole seal of low permeability.

Due to the size of the coarse grade bentonites, care should be taken in their use. Since the material cannot be pumped, placement of the material requires pouring from the surface. Placement may be accompanied by tamping to insure that bridging has not occurred. The bentonite must be poured slowly, and the pouring rate should not exceed the manufacturer's specifications.

Prior to using this material, it should be sieved through 1/4-inch mesh screen to remove fines which have accumulated in the bag during shipment. These fines, if not removed, will clump if they hit water and increase chances of bridging. Water should be poured on top of any coarse grade bentonite above the water table to induce swelling.

Pelletized Bentonite

The pelletized bentonite consists of 1/4 to 1/2-inch size, compressed bentonite pellets. As with coarse grade bentonite, pelletized bentonite provides a dense and flexible seal. Pelletized bentonite can be poured directly into the well through standing water. Precautions similar to those for the use of coarse grade bentonite are required to avoid bridging.

Availability Of Bentonite Grout Materials

Bentonite products are not as widely available as Portland cement and must be obtained from water well equipment suppliers. New bentonite grouting products with higher solids and improved workability will most likely be developed by the bentonite industry in the future.

Fill Materials

Complete filling with a bentonite material may not be economically feasible in wells that have exceedingly large volumes. Most wells in this category are of large diameter and, therefore, present a physical hazard. This type of well must be filled with load-bearing materials (Gordon, 1988). For example, large diameter, shallow dug wells can be filled with clean clay, such as that sold in 100 pound bags as fireclay (Peck, 1987). This clay, however, should not be used as a sealing material or fill material in other types of wells because it does not seal as effectively as commercially prepared bentonite products (Carlton, 1975) and can bridge in deeper, smaller diameter wells. There are other well types - such as wells completed in fractured limestones or extremely coarse gravel - that can contribute to the excessive loss of sealing materials. Fill materials can be used in such instances to bridge fractures and large voids in the water-producing zone before sealants are emplaced (Gordon, 1988).

There are a variety of low-cost materials which can be used to fill space where an impermeable seal is not required in a certain section of the borehole, as specified in the next section of these guidelines. Depending upon the application, these materials may be clean, disinfected sand, gravel, crushed stone, or clay. In all cases, the material should be clean — free of sticks, leaves, or other foreign matter. Additionally, the material should be free of any toxic chemical residue. All fill materials considered for well sealing should be sized to the well being sealed, meaning that the material should have particle-size diameters small enough not to cause bridging (Gordon, 1988).

Procedures for Sealing the Well

General Sealing Procedures

The first step in the well sealing process is to remove all obstructions from the well. These obstructions can include pumps and related equipment, such as drop pipes, **pitless adapters**, and suction lines. Pumps that are stuck and cannot be pulled should be pushed to the bottom of the hole, if possible. Other obstructions could consist of trash, animal remains, and debris such as large rocks or pieces of wood. If there is a possibility that the well has been contaminated, which could be evidenced by the presence of items such as empty pesticide containers, fertilizer bags, or a strong odor, the well owner should inform the appropriate agency (see Appendix 1) before sealing begins.

After the obstructions have been removed from the well, the next step is to decide what to do with the casing. As discussed earlier, the casing can be removed (by pulling, overdrilling, drilling out, or

jacking out), ripped or perforated, or left intact if the annular seal is judged to be adequate. The treatment of the casing will depend on the condition and type of casing, and the type of well being sealed. Another factor to consider when attempting casing removal is the type of formation in which the well is developed. Wells developed in unconsolidated formations should be sealed by simultaneously removing the casing and adding the sealing and /or fill material(s) to the well. This is necessary because once the casing is removed from a well developed in an unconsolidated formation, the borehole walls may collapse, preventing complete sealing of the borehole. It is highly recommended that this and all other steps in the sealing process be performed by an experienced registered drilling contractor.

Ripping or perforating a casing should be done by experienced registered drilling contractors that have the specialized tools needed for this work. Well casings should be ripped or perforated when the casing cannot be removed and:

- voids are known to exist between the casing and the formation, or
- there is a gravel pack (type of filter pack) between the two casings of a double-cased well, or
- the well is located in an area of known ground water contamination, or
- any combination of the above.

Overdrilling is not a commonly used method of casing removal in the water well industry; rather, it is used more often to remove casings from environmental wells. Overdrilling a well requires a drilling contractor to drill a larger diameter borehole over the existing well. The depth of the overdrilled borehole will depend on the construction of the well and local hydrogeologic conditions. After overdrilling, the casing can then be pulled. The borehole where the well was located is then grouted. Well casings should be overdrilled when the casing cannot be pulled, the condition of the annular seal is questionable, and:

- there is water flowing from around the outside of the well casing (this condition can occur in flowing wells), or
- the well is located in an area of known contamination, or
- there is gravel packing connecting two or more hydraulic zones.

Once the casing issue has been resolved, the next step is to disinfect the well. Chlorine is the most commonly used disinfection product, and is sold in many forms: bleach, tablets, pellets, powder, etc.. At concentrations of 150 to 200 parts per million (or milligrams per liter), the chlorine will kill any bacterial organisms that may exist in the water. As a result, water forced back into the formation by the sealing process will not cause bacterial contamination of any wells that are downgradient of the sealed well and developed in the same aquifer. The well may be disinfected before casing removal if it is suspected that the borehole may collapse after removal of the casing.

Installation of the sealing material follows the disinfection process. The method of installation and the sealing materials used must be matched to the type of well being sealed. In most situations (except for shallow wells), the method that provides the easiest installation and best seal is pressure grouting with a neat cement or bentonite slurry. Pressure grouting involves pumping a mixture of neat cement and water, or bentonite, polymer or initiator, and water down a small diameter plastic or steel pipe (called a tremie pipe) which has been lowered to the bottom of the borehole or well (Figure K). As the slurry is pumped, the pipe is pulled back at a rate that keeps the end of the pipe submerged in the slurry. The slurry will displace any water in the well and force it to the surface. The well has been filled when the slurry reaches the surface. Time should be allowed for any settlement of the slurry to occur before the final steps in the well sealing procedure are followed.

Precautions must be taken to ensure that the sealing material does not bridge when sealing wells with coarse grade bentonite products. Chipped bentonite products can be used in wells 200 feet deep or less. Pelletized bentonite products can be used in wells 100 feet deep or less. All coarse grade products used in wells less than 24" in diameter should be poured over a wire mesh screen to eliminate the fine bentonite powder that could cause bridging. These products should be poured at a rate no faster than 3 minutes per 50 pound bag (Figure L). The pouring process should be halted occasionally in order to lower a weighted measuring tape into the well until it reaches the top of the sealing products to confirm that bridging has not occurred. A tamping device should be used where possible to break any bridges that form. The total volume of products used to fill the well should be very close to

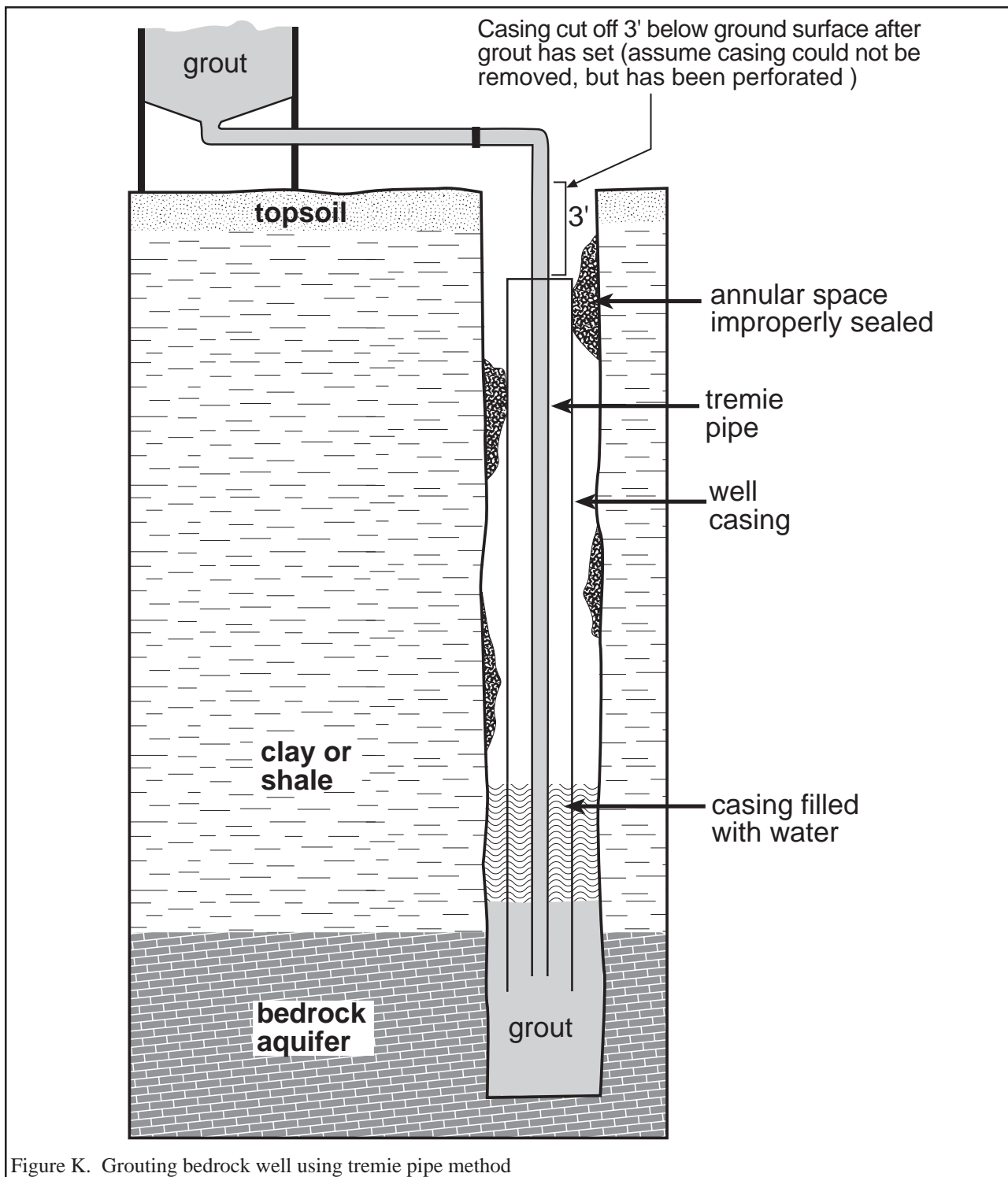
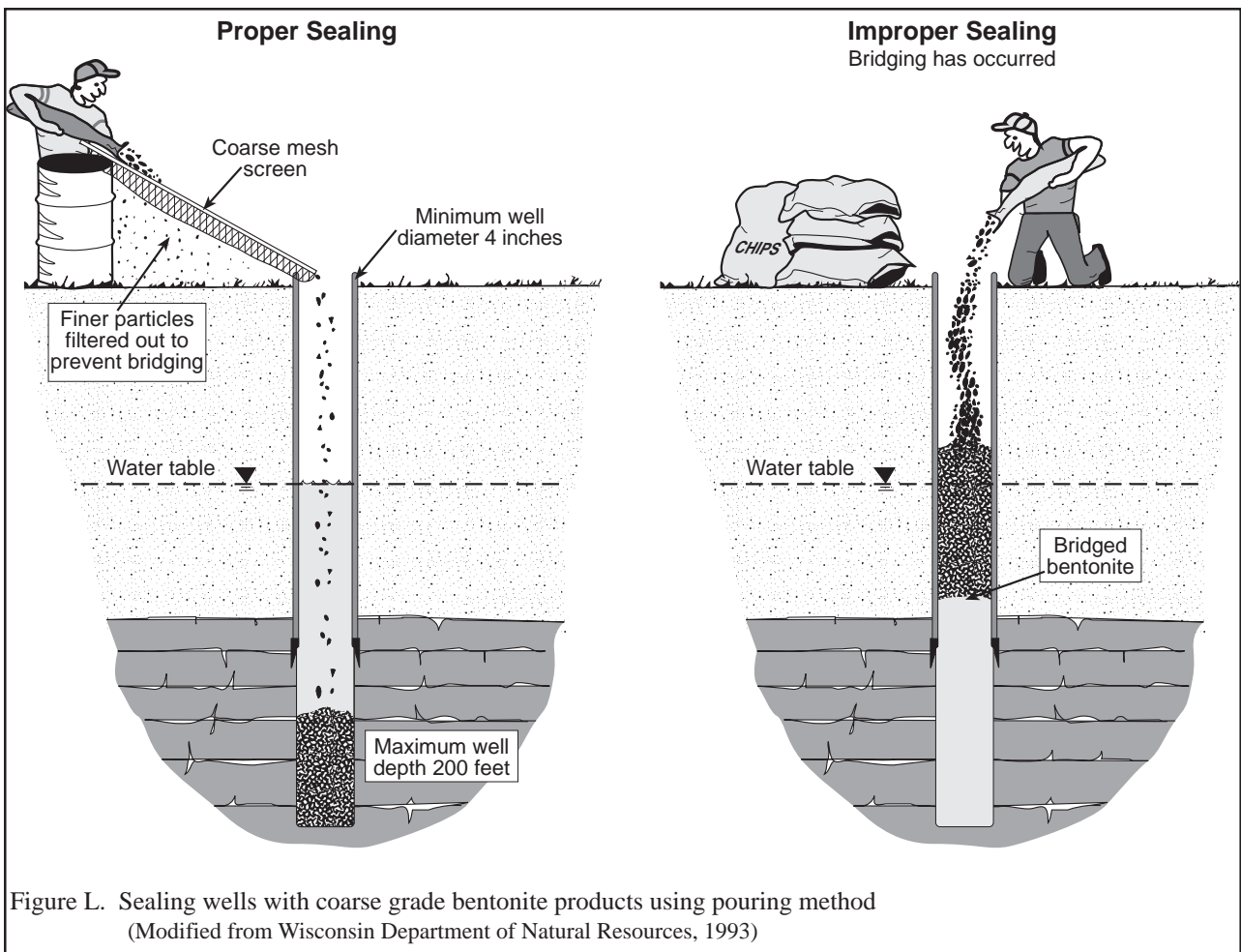


Figure K. Grouting bedrock well using tremie pipe method

the estimate of the amount needed for sealing. After the well has been sealed, it should be left unfinished overnight to see if any settling has occurred.

When the installation of sealing material has been completed, any remaining casing must be cut off to a depth of three to four feet below ground level. Then the remaining hole should be filled with clean soil and mounded at ground surface to ensure that surface water will drain away from the well. This procedure may be subject to change, depending upon the use of the land where the well is located.



The final step in the well sealing process is the submission of a well sealing report to the Ohio Department of Natural Resources, Division of Water (Figure A). This form is readily available from the Division of Water upon request, and most drilling contractors will have a supply on hand.

Specific Well Sealing Procedures

Sealing Dug and Bucket-Drilled Wells

The procedure for sealing dug and bucket-drilled wells differs somewhat from the general procedures described earlier in this guidance (Figure M). Once any obstructions are removed, the liner (casing equivalent) should be left intact except for the upper 3 to 5 feet (this number is dependent upon the measured static level in the well). The static water level in the well should be measured, and the well pumped dry if it contains water. The well should be disinfected, wet or dry.

Backfill with clean clay or cement to the measured water level if the static water level is less than five feet below ground surface, and the well is greater than twenty-four inches in diameter and twenty-five feet or less in depth. Remove the liner to the depth of the measured water level and excavate 6 inches beyond the original outside diameter of the well. Add a one foot thick layer of impermeable sealing material at the depth of the measured water level. This layer could consist of coarse grade bentonite or cement. If the impermeable sealing material used is coarse grade bentonite, it should be hydrated before completion if the well has been pumped dry. Five gallons of potable water should be added per fifty pound bag of bentonite. Fill the remainder of the well with clean soil and mound at ground surface to ensure drainage of surface water away from the well.

Backfill with clean clay or cement to the measured water level if the static water level is greater than five feet below the ground surface, and the well is greater than twenty-four inches in diameter and twenty-five feet or less in depth. Add a one foot thick layer of impermeable sealing material and

hydrate. Then add more clean clay or cement to three feet below the ground surface. Remove the top three feet of liner and excavate six inches beyond the original outside diameter of the well. Add another one foot of sealing material and hydrate it if necessary. Fill the remainder of the well with clean soil and mound at ground surface to facilitate drainage of surface water.

Wells less than or equal to twenty-four inches in diameter with water levels greater than five feet below ground surface, or, wells greater than twenty-four inches in diameter and greater than twenty five-feet in depth, should be treated as drilled wells and sealed in a manner appropriate for drilled wells.

Sealing Driven Wells

After inspection and removal of any obstructions, the well should be disinfected. Casing removal should then be attempted. The well should then be filled with coarse grade or pelletized bentonite, bentonite slurry, or cement slurry to ground surface. The casing should be cut off three feet below the ground surface if it was not successfully removed. The area excavated around the well to access the casing should be filled with clean soil and mounded at ground surface to ensure drainage of surface water away from the well.

Sealing Wells Drilled Through a Single Unconsolidated Aquifer or an Unconfined, Unconsolidated Aquifer

After any existing obstructions have been removed from the well, the casing should be removed, ripped or perforated, or left intact. The type and condition of the casing will determine which procedure should be attempted. Before installing the sealing materials, the well should be disinfected. Then, clean sand and/or gravel can be placed from the bottom of the well to the top of the aquifer, or to twenty-five feet below ground surface, whichever is encountered first. Next, the well should be pressure grouted with bentonite or cement slurry, or coarse grade bentonite products can be slowly poured, from twenty-five feet to ground surface. Hydrate any coarse grade or pelletized bentonite products used, if necessary. Periodically tamp the coarse grade bentonite products to prevent bridging. These filling and sealing procedures should be done as the casing is being removed from the hole, if removal is to be attempted. If the well is not of great depth or large diameter, an alternative sealing method would be to pressure grout the entire well bore from bottom to ground surface with bentonite or cement slurry as the casing is being removed from the hole.

The casing should be cut off three feet below ground surface if it was not removed while sealing. The remaining excavation should be filled with clean soil and mounded at ground surface.

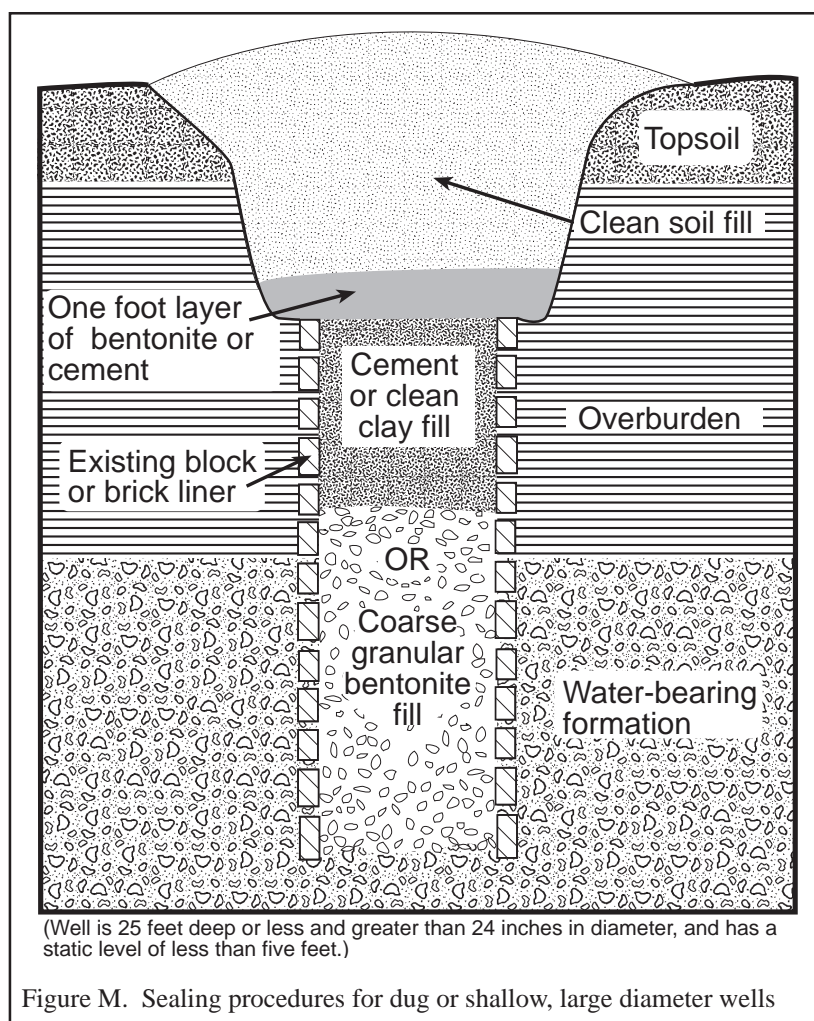


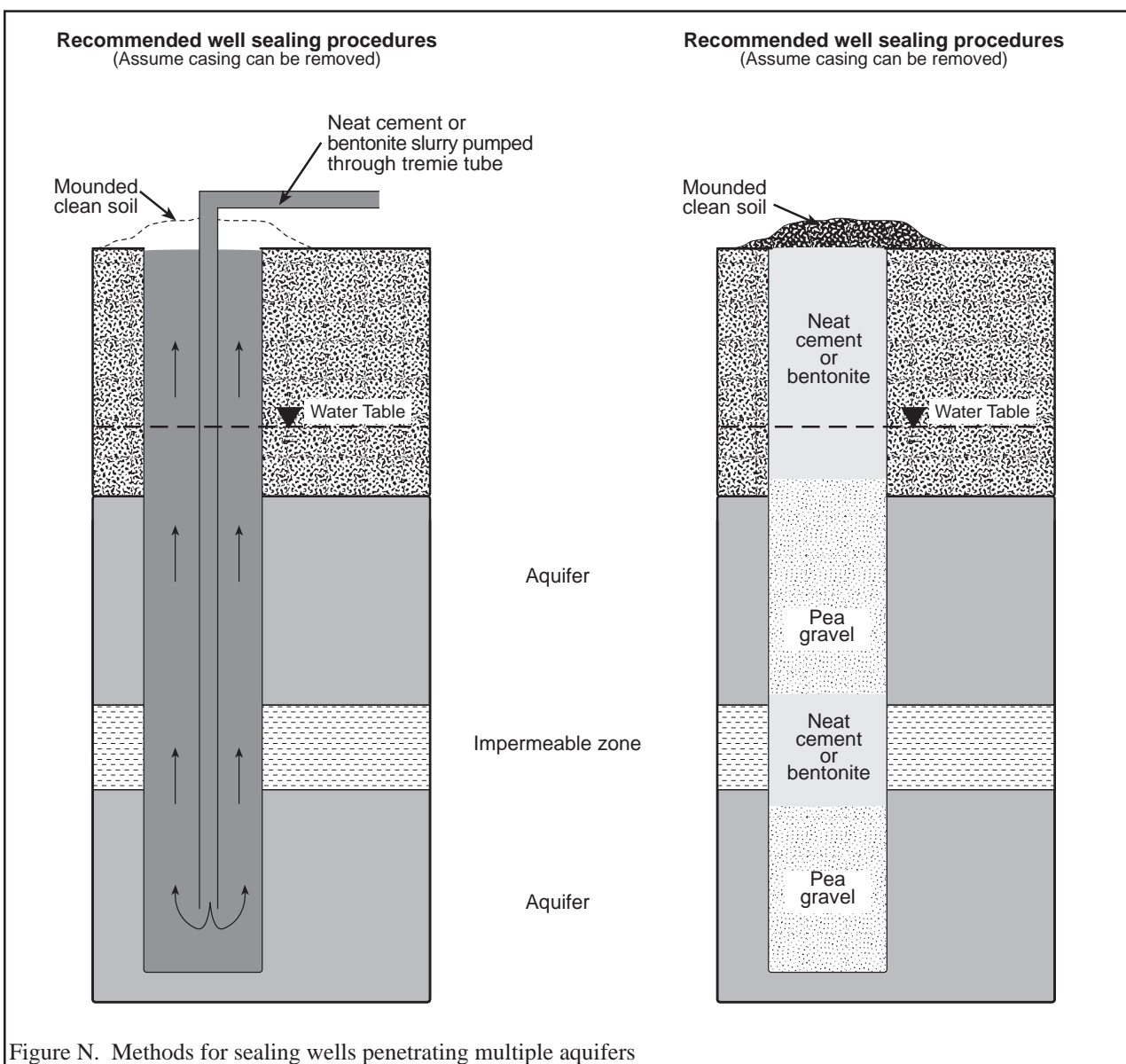
Figure M. Sealing procedures for dug or shallow, large diameter wells

Sealing Wells Drilled Through Multiple Unconsolidated Aquifers

Remove any obstructions present in the well. After the well has been disinfected, simultaneously install the sealing materials and remove the casing, if it is to be removed. The well should be pressure grouted from the bottom of the well to ground surface with bentonite or cement slurry if the well penetrates multiple aquifers but is open only to one, or penetrates multiple aquifers and is screened across multiple zones. Or, if there is detailed information available on the depth and thickness of each aquifer penetrated, it may be possible to place clean sand and/or gravel within each aquifer zone, and place an impermeable sealing material, such as neat cement or bentonite products, between each aquifer corresponding to the confining unit present (Figure N). Then the well should be sealed from the top of the uppermost aquifer to the surface with neat cement or bentonite products. Coarse grade bentonite products (chips) can be slowly poured into the well until they appear at ground surface if the well is 200 feet deep or less, and is 4 inches or more in diameter (Figure N). Pelletized bentonite products can be used if the well is 100 feet deep or less, and is 4 inches or more in diameter. These bentonite products, when used, should be periodically hydrated, if necessary, and periodically tamped to prevent bridging.

Any casing not removed should be cut off three feet below ground level, and the remainder of the well can be filled with clean soil and mounded at ground surface.

Sealing Wells Drilled Through Confined, Unconsolidated Aquifers



Wells drilled through confined aquifers can be difficult to seal because they can flow. This guidance strongly recommends that an experienced registered drilling contractor be consulted in all sealing situations, but it is especially important when dealing with these types of wells.

Once any obstructions are cleared, the casing must be removed, ripped or perforated, or left intact, depending upon the condition of the casing and the proposed sealing method. The well should then be disinfected, if possible, before the sealing materials are installed. If the well is not flowing, clean sand and/or gravel may be placed from the bottom of the well to the top of the producing zone or to twenty-five feet below the ground surface, whichever is encountered first. This should be followed by pressure grouting with cement or bentonite slurry, or by slowly pouring in coarse grade bentonite products or pelletized bentonite, from twenty-five feet to ground surface. Any coarse grade bentonite products used should be periodically hydrated, if necessary, and tamped to prevent bridging.

If the well is flowing from within the casing only, an attempt should be made to determine the hydraulic head. Extend the casing high enough to keep the well from flowing if the hydraulic head is low enough to permit casing extension (Figure O(1)). Pressure grout with cement from the bottom of the well to the ground surface. Coarse grade bentonite products (100 feet or less for pelletized bentonite, 200 feet or less for chipped) may be poured from the bottom of the well to ground surface if the

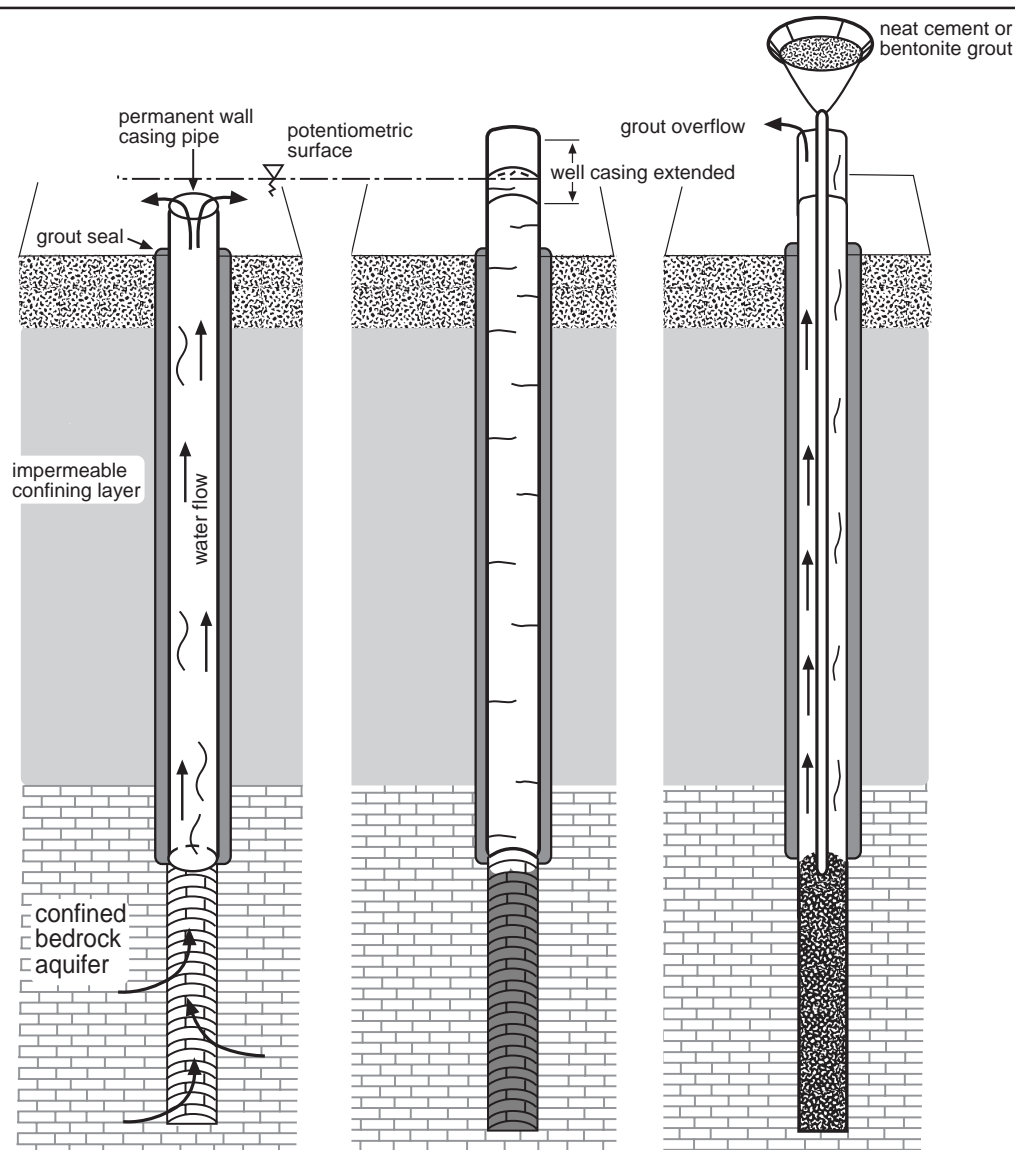
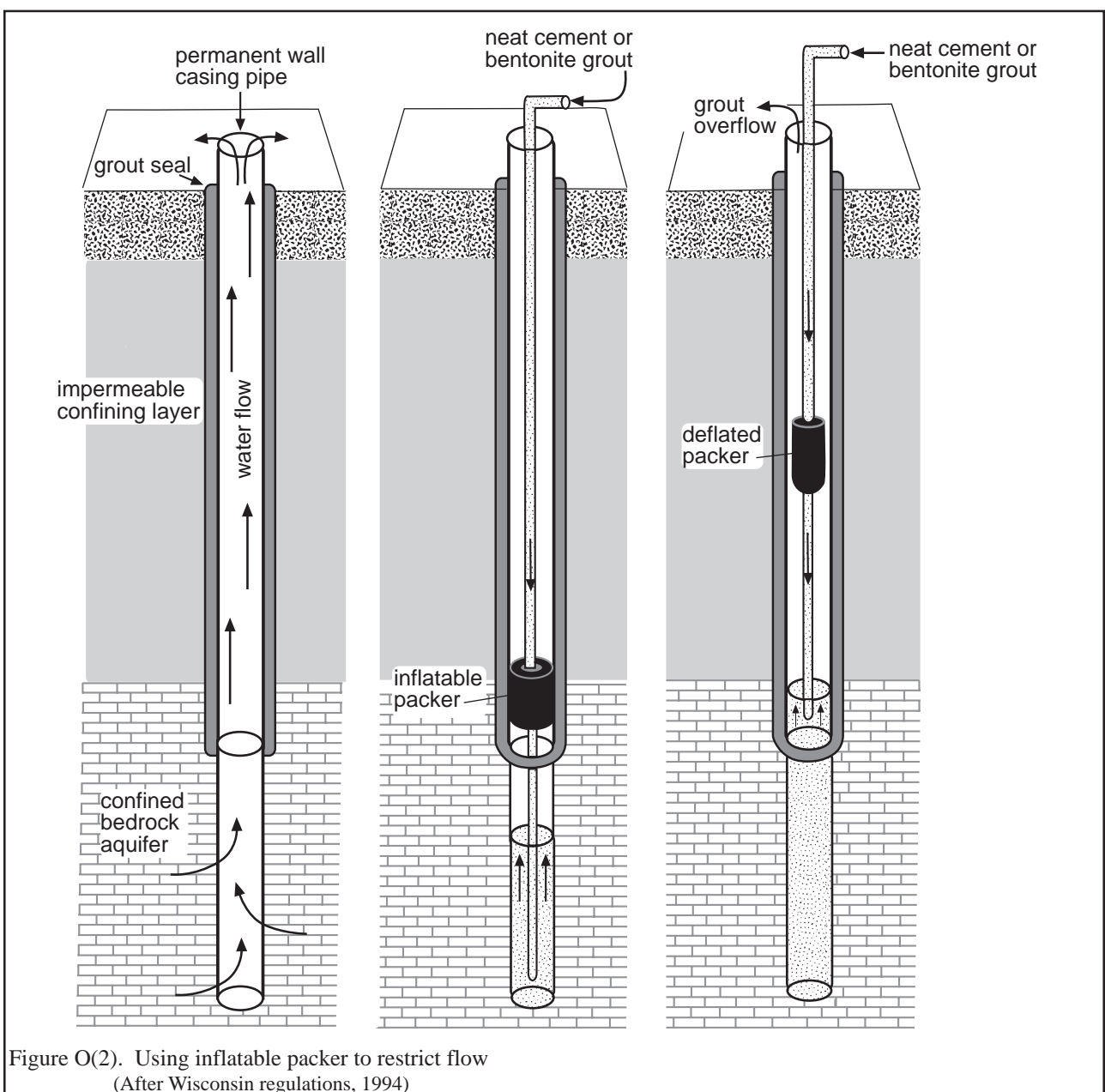


Figure O(1). Reducing or stopping flow of well by casing extension
(After Wisconsin regulations, 1994)

flow has been completely stopped by casing extension. The casing can then be cut off three to four feet below ground surface, and the remaining excavation filled with clean soil and mounded.

The well can be sealed by attempting to stop the flow, or by other methods that will allow sealing while the well is flowing, if the hydraulic head is too high to permit casing extension. An inflatable packer should be placed at the top of the producing formation to attempt to stop or restrict the flow (Figure O(2)). Then the well can be pressure grouted with cement or bentonite slurry through the packer from the bottom of the hole to the bottom of the packer. The packer can then be deflated and grouting continued to ground surface. It may also be possible to stop the flow by placing a shut-in device on top of the well. A tremie tube can be inserted through the shut-in device and the well pressure grouted with cement or bentonite slurry from the bottom of the well to the ground surface.

Another alternative for slowing the flow is to pour disinfected gravel into the well in an attempt to reduce the flow to a point where it becomes possible to use pressure grouting equipment to seal the well (Figure O(3)). Once the grout has set, any remaining casing can be cut off three to four feet below the ground surface. The resulting hole can then be filled with clean soil and mounded at ground surface.



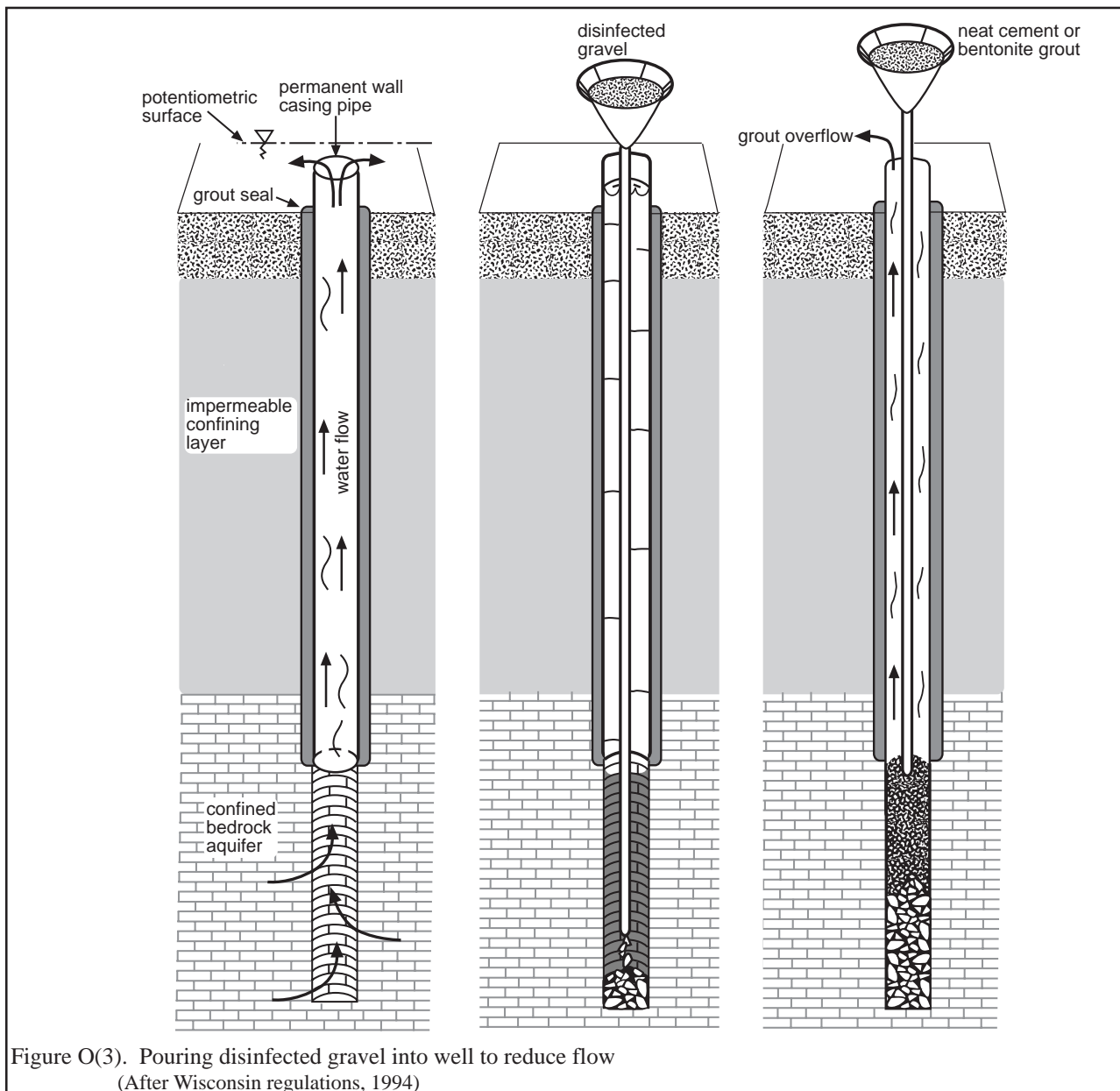
The well should be pressure grouted continuously from bottom to top with a fast setting cement if the well is flowing from within the casing and around the outside of the casing, and if the casing can be removed by overdrilling. If the casing cannot be removed, tremie lines should be run along the outside of the casing if there is an annular space, and down through the middle of the casing, so that the well bore and the annular space can be continuously and simultaneously pressure grouted from the bottom of the well to the ground surface.

Sealing Wells Drilled Through Single Consolidated Aquifers

These types of wells should be sealed in the same manner as wells drilled through single unconsolidated aquifers, except that the casing removal and sealing need not occur simultaneously. Please refer to that section for sealing procedures.

Sealing Wells Drilled Through Multiple Consolidated Aquifers

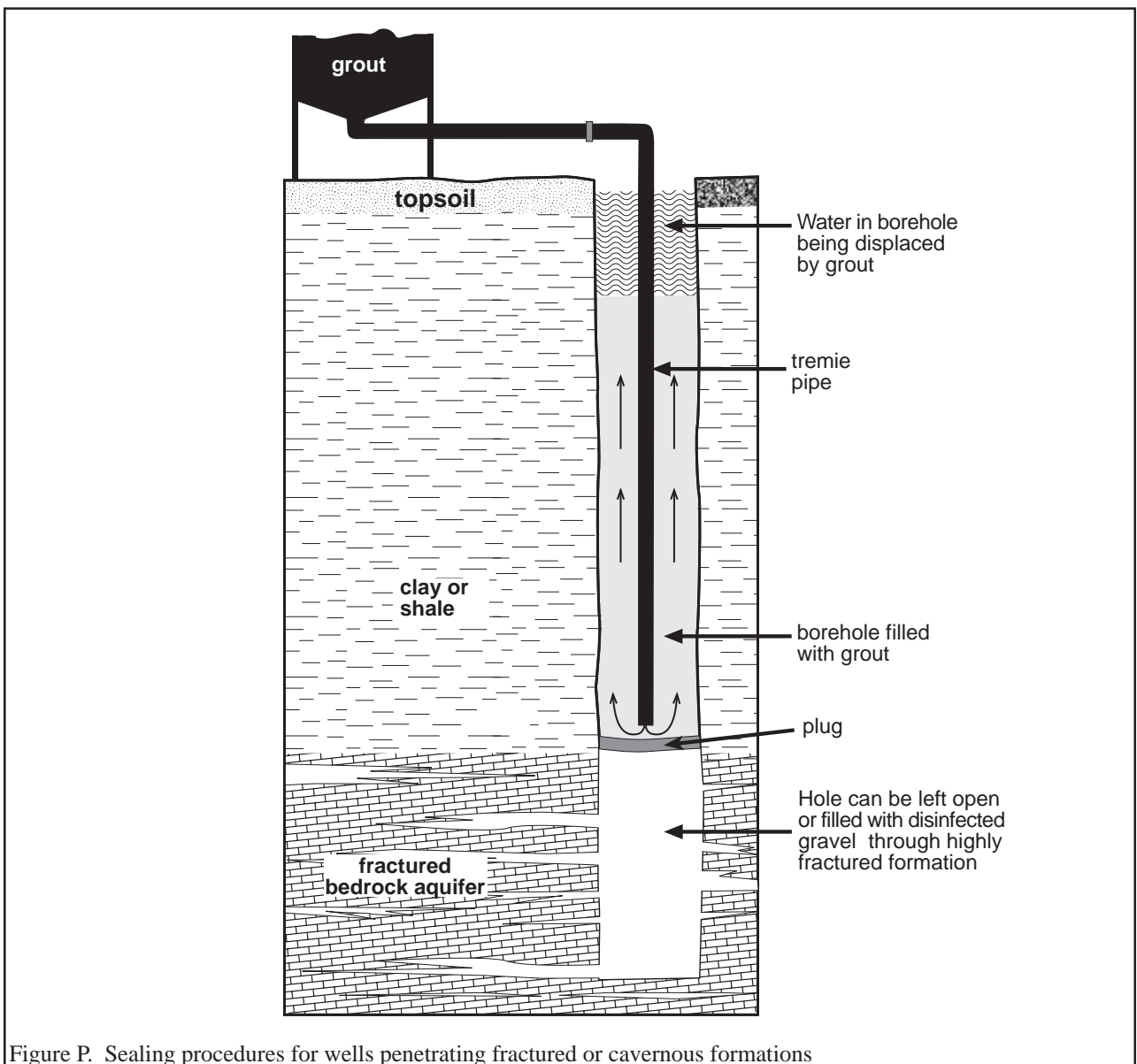
Any obstructions should be removed and the casing should be removed, perforated, ripped, or left intact. The well then should be disinfected prior to the installation of the sealing materials. The well should be pressure grouted with cement or bentonite slurry from the bottom of the well to the ground surface. Alternatively, if there is enough information available about the construction of the well and



formations penetrated, gravel fill can be used in the water-bearing zones, while an impermeable sealing material (bentonite or cement) can be used to seal the confining layers. An impermeable material also can be used as a seal from the top of the uppermost aquifer to the surface. Any remaining casing should then be cut off three to four feet below the ground surface, and the resulting excavation should be filled with clean soil and mounded. Refer to Figure N for details on these sealing methods.

Sealing Wells Drilled Through Fractured or Cavernous Formations

Once initial issues of obstructions, casing, and disinfection have been taken care of, the next step is to try to determine the depth(s) at which the fractured or cavernous zones occur. During sealing, a plug may be placed above the cavernous interval, and then the well may be pressure grouted with cement or bentonite slurry from the top of the plug to the ground surface. A well with a highly fractured zone of known depth could be sealed in the same manner (Figure P). The well could be filled with coarse gravel to the top of the fractured or cavernous zone, and then pressure grouted from the top of that zone to the ground surface (no plug would be needed above the gravel fill) if the fractured or cavernous zone is not extensive. The casing should be cut off three to four feet below the ground surface, and the remaining hole filled with clean soil and mounded, to complete the sealing process.



Sealing Flowing Wells Drilled Through Single or Multiple Consolidated Aquifers

Flowing wells drilled through consolidated aquifers can be sealed in the same manner as wells drilled through confined, unconsolidated aquifers. Please refer to the procedures in that section for well sealing information.

Sealing Wells of Unknown Construction

After any obstructions have been removed, the casing should be left in place due to the lack of information on the construction details of the well. Disinfect the well, then attempt to determine the depth of the well. The well should be pressure grouted from bottom to top with bentonite or cement slurry if the depth of the well is 300 feet or less, and the diameter is twenty four inches or less. Wells greater than 300 feet in depth should be pressure grouted as well, but specialized equipment may be required to pump grout to these depths.

The casing should be cut off three to four feet below ground surface. The remainder of the well should be filled with clean soil and mounded at ground surface.

The final step in all of these well sealing procedures is to file a well sealing report with the Ohio Department of Natural Resources, Division of Water. A summary of all the well sealing procedures discussed in this section can be found in Table 5.

Conclusions

Unsealed or improperly sealed abandoned wells present a very real threat to the quality of ground water in Ohio. With potentially as many as 200,000 existing abandoned wells scattered across the state, it is apparent that steps must be taken now to guarantee the future quality of the state's ground water resources.

The guidelines outlined in this document are the result of a genuine need for information on how to seal abandoned wells properly. While these guidelines are not intended to cover every possible scenario, they can certainly serve as a reference for basic methodologies to be followed in commonly encountered situations. It is strongly recommended that a well owner consult an experienced registered drilling contractor when preparing to seal a well. This is the best way to ensure that the well will be sealed in a manner appropriate for that type of well under those specific geologic conditions.

WELL TYPE		MATERIALS							METHOD OF INSTALLATION
		Clean fill		Concrete	Neat cement slurry	Coarse grade bentonite		Bentonite slurry w/70 second viscosity	
						Chips	Pellets		
UNCONSOLIDATED FORMATION(S)	Dug & bucket-drilled wells >24" in diam. and ≤ 25' in depth	No	Yes-to static level ¹	No	Yes	Yes	Yes	No	Material may be poured into well
		No	No	No	Yes	Yes ⁵	Yes ⁵	Yes	Slurry must be tremied, coarse grade bentonite must be slow-poured ²
	Wells drilled through single aquifer ≤ 24' in diam., >25' deep	Yes- to top of aquifer or 25' below ground surface ³	No	Yes	Yes	Yes ²	Yes ²	Yes	Slurry must be tremied, gravel may be poured, coarse grade bentonite must be slow-poured
	Wells drilled through multiple aquifers ≤ 24" in diam., >25' deep	Yes ⁴	No	No	Yes	Yes ²	Yes ²	Yes	Slurry must be tremied, coarse grade bentonite must be slow-poured
	Flowing wells drilled through single or multiple aquifers	No ⁷	No	Yes	Yes	Yes ⁶	Yes ⁶	Yes	Slurry must be tremied
CONSOLIDATED FORMATION(S)	Wells drilled through single aquifer ≤ 24' in diam., >25' deep	Yes-to top of aquifer or 25' below ground surface ³	No	No	Yes	Yes	Yes ²	Yes	Slurry must be tremied, gravel poured, coarse grade bentonite must be slow-poured
	Wells drilled through multiple aquifers ≤ 24" in diam., >25' deep	Yes ⁴	No	No	Yes	Yes	Yes ²	Yes	Slurry must be tremied, gravel poured, coarse grade bentonite slow-poured
	Wells drilled through fractured or cavernous formations	Yes-through fractured or cavernous zones only	No	Yes	Yes-from top of plug or cavern fill to surface	Yes-from top of plug or cavern fill to surface	Yes-from top of plug or cavern fill to surface	Yes-from top of plug or cavern fill to surface	Slurry must be tremied, gravel only (no sand should be used) poured, coarse grade bentonite slow-poured
	Flowing wells drilled through single or multiple aquifers	No ⁷	No	Yes	Yes	Yes ⁶	Yes ⁶	Yes	Slurry must be tremied
Drilled wells of unknown construction		No	No	No	Yes	Yes	No	Yes	Slurry must be tremied
Any wells >24" in diam. and >25' deep		Yes ⁴	No	No	Yes	Yes	Yes ²	Yes	Slurry must be tremied, chips and pellets must be slow-poured and tamped periodically

¹ The clay fill must be topped with a 1 ft. thick layer of bentonite or cement extending 6" beyond the original outside diameter of the well.

² The bentonite chips or pellets must be poured slowly over a wire mesh screen and into the well at a rate no faster than 3 minutes per 50 pound bag. Pellets should be used in wells no deeper than 100 feet, chips in wells no deeper than 200 feet. These products should be tamped periodically and hydrated if they are placed above the water table, or if the well is dry. The diameter of the well must be 4' or greater.

³ The well should then be filled to the surface with cement or bentonite products.

⁴ Gravel and/or sand may be used in aquifer zones provided there is an impermeable plug of bentonite or cement placed between these zones, and from the top of the uppermost zone to the surface.

⁵ Coarse grade bentonite may be used in wells 25 feet deep or less as long as it is tamped periodically. Wells deeper than 25 feet must be sealed with a tremied slurry.

⁶ Coarse grade bentonite may be used if flow has been stopped by casing extension and products are able to fall to the bottom of the well. Well should be 200 feet deep or less, and at least 4 inches in diameter.

⁷ Gravel may be used in flowing wells only to slow flow enough to allow grouting to proceed.

Table 5 Summary of Recommended Well Sealing Procedures

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Glossary

Annular space	the space between the well casing and the borehole wall.
Aquifer	a geological formation, part of a formation, or group of formations that is capable of yielding a significant amount of water to a well or spring.
Bailing	the use of a bucket, or rigid tube or pipe with a valve to remove fluid volumes or debris and cuttings from a well.
Borehole	a hole in the earth made by a drill; the uncased drill hole from the surface to the bottom of the well.
Casing	an impervious, durable pipe placed in a well to prevent the walls from caving and to seal off surface drainage or undesirable water, gas, or other fluids, and prevent their entering the well.
Cistern	a large receptacle used for storing water, especially an underground tank in which rainwater is collected.
Confining bed	a body of impermeable or distinctly less permeable material stratigraphically adjacent to one or more aquifers.
Confined aquifer	an aquifer bounded above and below by beds of distinctly lower permeability than that of the aquifer itself and which contains groundwater under pressure greater than that of the atmosphere. This term is synonymous with the term “artesian aquifer.”
Consolidated	lithified geologic materials. In Ohio, these materials constitute formations such as sandstone, limestone, and shale.
Cuttings	chips removed from the borehole by a bit in the process of well drilling.
Density	the mass or quantity of a substance per unit volume, usually expressed in grams per cubic centimeter.
Drill rod	the extension rods used to attach the bit to the drilling rig to enable the penetration into the earth.
Drill bit	a device used on the end of a drilling stem or rod for the purpose of penetrating earth formations. Drilling bits are usually made of a hardened material so as to last an extended period of time.
Drilling mud	a special mixture of clay, water, and chemical additives pumped down hole through the drill pipe and drill bit. The mud is used to lubricate and cool the bit and to float cuttings to the surface for removal.
Drill tools	general term associated with all equipment used in the drilling process. Tools, bits, rods, stems, etc.
Dug well	a well excavated into a generally shallow, unconsolidated aquifer in which the side walls may be supported by material other than standard weight steel casing.
Filter pack	siliceous, well-rounded, clean, and uniform sand or gravel that is placed between the borehole wall and the well screen to prevent formation material from entering through the screen.
Formation	a body of consolidated or unconsolidated rock characterized by a degree of lithologic homogeneity which is prevailing, but not necessarily, tabular and is mappable on the earth’s surface or traceable in the subsurface.
Geologic conditions	the distribution, types, and structural features of earth materials present in any given area.

Geotechnical boring	borings installed to determine the geological and engineering properties of subsurface soils.
Ground water	any water below the surface of the earth in a zone of saturation.
Grout	As used in these guidelines, grout is a fluid mixture of water and cement or water and bentonite that is of a consistency to be pumped through a small-diameter pipe.
Hydrated	the incorporation of water into the chemical composition of mineral.
Hydraulic head	the height of the free surface of a body of water above a given subsurface point; a reflection of the ground water level plus the pressure head.
Hydrogeologic conditions	the occurrence, distribution, and quality of subsurface water within consolidated and/or unconsolidated earth materials in a given area.
Mesh	one of the openings in a screen or sieve. The value of the mesh is usually given as the number of openings per linear inch.
Microannulus	for the purpose of this guidance document the term means the space between the sealing material and the casing and/or the formation. This is caused by the shrinkage of the sealing material.
Monitoring well	any excavation that is drilled, cored, bored, washed, driven, dug, jetted, or otherwise constructed for the purpose of extracting groundwater for physical, chemical, or biological testing, or for the purpose of determining the quantity or static level of ground water on a continuing basis.
Mud balance	a scale that measures a specific volume of grout slurry (density) and is expressed in pounds per gallon.
Permeability	the capacity of a porous rock, sediment, or soil for transmitting fluid; a measure of the relative ease of fluid flow across a pressure gradient.
Pitless adapter	a device or an assembly of parts which permits water to pass through the casing or extension thereof; provides access to the well and to the parts of the water system within the well; and provides for the transportation of the water and the protection of the well and water therein from surface or near surface contaminants.
Plasticity	the capability of being deformed permanently without rupture.
Pore	a tiny opening, usually microscopic, in consolidated or unconsolidated materials.
Recharge	the processes by which water is absorbed and is added to the saturation zone, either directly into a formation, or indirectly by way of another formation.
Saturated zone	the portion of consolidated or unconsolidated materials in which all of the pore space is occupied by water.
Static level	the distance measured from the established ground surface to the water surface in a well being neither pumped nor under the influence of pumping nor flowing under artesian pressure.
Stratigraphic	the arrangement of consolidated and unconsolidated strata.
Test boring	a boring designed to obtain information on ground water quality and/or geological and hydrogeological conditions.
Unconsolidated	not lithified but loose, soft geologic materials. Alluvium, soil, gravel, clay, and overburden are some of the terms used to describe a formation consisting of unconsolidated materials.
Viscosity	the property of a fluid or semi-liquid to offer internal resistance to flow.
Well	any excavation, regardless of design or method of construction, created for

any of the following purposes: (1) removing ground water from or recharging water into an aquifer; (2) determining the quantity, quality, level, or movement of ground water in or the stratigraphy of an aquifer; and (3) removing or exchanging heat from ground water.

Well screen

a machine-slotted or wire-wrapped portion of casing used to stabilize the sides of the borehole, prevent the movement of fine-grained material into the well, and allow the maximum amount of water to enter the well with a minimum of resistance.

Yield

the quantity of water which may flow or be pumped from the well per unit of time.

Appendix 1

Contact Agencies

Ohio Department of Agriculture, Pesticide Regulation Section

The Ohio Department of Agriculture (ODA) does not currently provide routine well analysis for pesticides; however, the Pesticide Regulation Section of ODA will sample any well where it is suspected that the use of a pesticide may have contaminated the well. Samples must be collected by an ODA inspector to protect sample integrity, and then analyzed at the ODA laboratory in Reynoldsburg. The Pesticide Regulation Section will investigate to determine how the well was contaminated if a water sample is positive for a pesticide. The ODA will advise the well owner on how to clean up the well, and, if necessary, take appropriate enforcement action under Ohio Pesticide Law. The Ohio Department of Agriculture can be contacted at 614-728-6200.

Ohio Department of Commerce, Division of State Fire Marshal, Bureau of Underground Storage Tank Regulations (BUSTR)

In the event that any potable or non-potable water well is suspected of being contaminated with petroleum from a leaking petroleum underground storage tank (such as those used at gas stations), contact BUSTR at 1-800-686-2878 before sealing the well.

Ohio Department of Health, Division of Quality Assurance

For information on specific regulatory requirements for sealing private wells, or for questions about possible contamination with substances other than pesticides or petroleum products, contact the local health department or the Ohio Department of Health Private, Water System Program (PWSP) at 614-466-1390.

To determine the registration status of a particular private water system contractor (i.e., drilling contractor or pump installer), contact the local health department or the ODH-PWSP Public Inquiries Assistant at 614-466-0148.

Ohio Department of Natural Resources, Division of Mines & Reclamation

The Division of Mines and Reclamation regulates the abandonment of test borings for coal and industrial minerals exploration through the permitting process under the Ohio Revised Code Chapter 1513 and 1514. Most exploratory borings are mined through the removal of the coal or industrial mineral. Those borings that are not removed by mining are required to be properly sealed using procedures approved by the Division. The Division also recommends that the coal operator properly seal any original private water supply wells that are replaced by a new well drilled as a result of a water supply replacement order by the Chief. The Division investigates any ground water contamination complaints related to coal and industrial minerals mining activities.

Ohio Department of Natural Resources, Division of Oil & Gas

Personnel in the Groundwater Protection Section of the Division investigate ground water contamination cases when oil and gas operations are the suspected cause. If there is reason to believe that an unsealed, unused well on a property is an oil or gas well, the Division also has an Idle and Orphan Well Program that addresses the need to seal abandoned oil and gas wells. For more information on these two programs, contact the Division's Central Office at 614-265-6926.

Ohio Department of Natural Resources, Division of Water

The Ohio Revised Code, Section 1521.05, requires that a well sealing report be filed with the Division of Water for all wells sealed in the State of Ohio. Copies of the well sealing report can be obtained from the Division by calling 614-265-6739. The Division also collects well log and drilling reports required to be filed by drilling contractors for wells drilled across the state. This authority also comes from Section 1521.05 of the Ohio Revised Code. Requests for copies of well log and drilling reports on file can be made by calling 614-265-6740.

Ohio Environmental Protection Agency

The Ohio Revised Code 6111.42 gives the Ohio EPA authority to prescribe regulations for the drilling, operation, maintenance, and sealing of abandoned wells as deemed necessary by the director to prevent the contamination of underground waters in the state, except that such regulations do not

apply to non-public potable wells. Currently, the Ohio EPA, Division of Drinking and Ground Waters, has regulations for the sealing of public water supply wells (OAC 3745-9-10) and for wells used for the purpose of injecting fluids into the ground (OAC 3745-34-07, 60, and 36). Sealing of monitoring wells is generally handled by the Division that has regulatory authority over the site/facility. For information on specific regulatory requirements for public drinking water wells or for injection wells, the Division of Drinking and Ground Waters should be contacted at 614-644-2752.

The Ohio EPA has no regulations/requirements for a person to report contamination in their private well. Reporting of ground water contamination is only required if an entity is monitoring ground water in accordance with hazardous or solid waste rules. In general, the Ohio EPA will not respond to a request to evaluate a contaminated private well unless the local or state health department requests assistance in investigating the source of the problem. However, this will not affect how the well should be sealed, but may affect when it is sealed if additional investigation is initiated.

An exception to this occurs if the well was used to inject fluid waste. If it was used as an injection well, the owner/operator must contact the Division of Drinking and Ground Waters, Underground Injection Control Unit (U.I.C.) of the Ohio EPA at 614-644-2905. Specific requirements must be followed for the sealing of injection wells.

Appendix 2

Cost Considerations

When obtaining estimates for well sealing from local drilling contractors, it is necessary to understand upon what the contractor's price will be based. As seen in the guidelines, there are many steps in sealing a well properly. The preliminary steps, which involve researching the history of the well by obtaining a well log and drilling report or talking to neighbors, can be done by the well owner. However, except perhaps in the case of shallow dug wells, the remaining steps of the sealing process should be handled by a registered drilling contractor with experience in sealing abandoned wells.

The contractor must consider many factors in order to provide the best estimate possible. Besides the cost of the materials used to seal the well, the contractor must also consider the cost of the labor and equipment used to install them. For example (brand names used in this section are for illustrative purposes only and do not imply an endorsement of any particular product), most contractors can currently buy a bag of Benseal (a granular bentonite product installed in slurry form) from their supplier for approximately \$7 per bag. The contractor must then add the cost of labor for installing the Benseal, the cost of the pumping equipment, and the cost of the polymer mixed with the Benseal. This will raise the price per bag of Benseal to approximately \$75 per bag, installed. Multiply this by the 5 bags it takes to seal a 100 foot deep, 6 inch diameter well (see Table 6, and note that the number of bags required has been rounded up to the nearest whole bag), and the result is an estimate of \$375. Or, suppose the well is to be sealed with a neat cement slurry. The installed price of cement slurry per bag is about \$30. To seal the same well cited above, it will cost almost \$480 because it will take nearly 16 bags of cement to fill the well (Table 6). These prices will probably not reflect the removal of any obstructions from the well, such as pumping equipment, the disinfection of the well, or removing, perforating, or cutting off the casing. These are all factors that will affect the contractor's estimate.

Another commonly used well sealing material is coarse grade bentonite, which consists of chips of bentonite ranging from $\frac{3}{8}$ " to $\frac{3}{4}$ " in size. Coarse grade bentonite is poured into the well, not pumped like a slurry. Therefore, the equipment and labor costs are lower. Assume that Holeplug is to be used to seal a 100 foot deep, 6 inch diameter well. Most contractors could probably purchase Holeplug from their suppliers for about \$7 per bag. Add labor to install the Holeplug, and the price is raised to approximately \$15 per bag. However, it will take almost 29 bags of Holeplug (Table 6) to fill the well. The result is a cost estimate of \$435. Then, any of the factors mentioned in the previous discussion could add to this cost.

In some cases, more than one type of material may be used to seal the well. If the well to be sealed penetrates a highly fractured bedrock formation, such as limestone, the contractor may wish to fill the fractured portion of the well with gravel or aggregate, then finish the sealing process with a cement or bentonite slurry or a coarse grade bentonite product. Table 6 shows volumes of a standard size aggregate required to fill wells of varying depths and diameters. One cubic yard (27 cubic feet) of #8 aggregate (roughly $\frac{3}{8}$ " in size) averages about \$16. With labor included the cost averages \$40. Keep in mind that the well should not be filled entirely with this aggregate. There must be impermeable material between the top of the aggregate layer and the ground surface. This type of sealing procedure should be used only under certain geologic conditions.

The most costly factor in sealing a water well is removing or perforating the casing. Depending upon the equipment used to remove or perforate the casing and the hours of labor involved in the process, the cost of the well sealing operation could be increased anywhere from \$200 to \$500. Some of the other factors, such as removing existing pumping equipment and cutting off the casing below ground surface, also may be labor intensive if any difficulties are encountered. This too will add to the total sealing price.

Obviously, there are many factors to be considered when a contractor provides an estimate for sealing a well. By being aware of these factors, the well owner can ask the contractor intelligent questions and be involved in the estimation process. This also will give the well owner a basis for evaluating different estimates to determine which contractor to hire to do the job.

Hole Diameter Inches	Gallons Per Foot	Gallons to be Plugged in 100' well	Bags Required to Plug a 100 ft Well*			Hole Volume Cu Ft/Ft depth	Feet Filled by One Bag of Holeplug	Bags of Holeplug to Fill 100' Well*	Cu Ft of #8 Aggregate to Fill a 100' Well
			Benseal	Enviroplug	Neat Cement				
2	0.17	17	1	1	2	0.022	31.30	4	2.2
3	0.38	38	2	2	4	0.049	14.30	7	4.9
4	0.67	67	3	3	7	0.087	7.90	13	8.7
5	1.00	100	4	5	11	0.136	5.10	20	13.6
6	1.51	151	5	7	16	0.196	3.50	29	19.6
7	2.05	205	7	10	22	0.267	2.60	39	26.7
8	2.70	270	9	13	28	0.349	2.00	51	34.9
9	3.40	340	11	16	35	0.442	1.60	64	44.2
10	4.20	420	13	19	44	0.545	1.30	79	54.5
11	5.00	500	16	23	52	0.660	1.10	95	66.0
12	6.00	600	19	27	62	0.785	0.89	113	78.5
15	9.50	950	30	43	98	1.227	0.57	177	122.7
18	13.60	1360	42	61	140	1.767	0.39	255	176.7
20	16.80	1680	52	75	173	2.181	0.32	315	218.1
25	26.00	2600	80	117	267	3.409	0.20	491	340.9
30	38.00	3800	117	170	390	4.909	0.14	707	490.9
60	152.00	15200	468	679	1559	20.322	0.04	2500	2032.2

* Number of bags has been rounded up to the next whole bag.

Yield Calculations:

Neat Cement: One 94 lb bag plus 6 gallons of water equals 9.75 gallons of grout
 Benseal: One 50 lb bag plus 10 oz. of E-Z Mud plus 30 gallons water equals 32.5 gallons of grout
 Enviroplug: One 50 lb bag plus 2.5 lb of activator plus 20 gallons of water equals 22.4 gallons of grout

Holeplug is a granular bentonite product, $\frac{3}{8}$ " – $\frac{3}{4}$ " in size that is poured, not pumped, into a well.

Table based on product information published by NL Baroid, Wyo-Ben. Inc., and Chemgrout Inc.

Table 6 Table Comparing Volumes of Different Well Sealing Materials Required to Seal a 100 Foot Well

Appendix 3

List of Acronyms

ASTM	-	American Society for Testing and Materials
API	-	American Petroleum Institute
BUSTR	-	Bureau of Underground Storage Tank Regulations
DDAGW	-	Division of Drinking and Ground Waters
EPA	-	Environmental Protection Agency
OAC	-	Ohio Administrative Code
ODA	-	Ohio Department of Agriculture
ODH	-	Ohio Department of Health
ODNR	-	Ohio Department of Natural Resources
ORC	-	Ohio Revised Code
PWSP	-	Private Water System Program
UIC	-	Underground Injection Control

Appendix 4

Sealing Monitoring Wells and Boreholes¹

Boreholes that are not completed as monitoring wells and monitoring wells that are no longer being sampled or used for ground water level measurements must be sealed properly to: 1) prevent poor quality water from one saturated zone entering another, 2) prevent contamination of the ground water by surface contaminants, 3) restore an aquifer to as close to its original condition as possible, 4) eliminate physical hazards, and 5) reduce potential for future liability. A suitable program should be designed and implemented to meet these objectives.

The sealing material and the method of sealing depend on: 1) the design and construction of the well/borehole, 2) hydrogeologic conditions, 3) chemical environment, 4) safety hazards and 5) disposal of contaminated materials removed. In general, well sealing should consist either of a method for well removal and simultaneous grouting of the borehole with bentonite, neat cement, or a method for grouting in-place that ensures complete sealing.

Sealing Materials

The chosen sealing material should:

- Not react with contaminants, ground water, or geologic materials.
- Have a hydraulic conductivity comparable to or lower than that of the in-situ material.
- Form a tight bond with the borehole wall and the casing.
- Be resistant to cracking and/or shrinking.
- Be of sufficient structural strength to withstand subsurface pressures.
- Be capable of being placed at the appropriate depth.

No single material will exhibit all of the characteristics mentioned above. Therefore, every situation must be evaluated carefully to determine the appropriate choice. Generally, materials used are comprised of concrete, neat cement, or sodium bentonite.

Most wells completed in unconsolidated formations or non-creviced rock may be satisfactorily sealed with neat cement or bentonite. Wells that penetrate limestone or other creviced or channeled rock formations should be filled with concrete grout or neat cement to ensure seal permanence. The use of fine-grained materials to seal creviced rock may not be desirable because the materials might be displaced by flow of water through crevices (American Water Works Association, 1984). Neat cement or sodium bentonite should be used for sealing an abandoned well/borehole below the water table (Gordon, 1988). Pure sodium bentonite placed above the water table should be hydrated if it is not installed in slurry form due to the lack of water for hydration of pellets or chips. At no time should a borehole or well be backfilled with cuttings or with any materials of unknown integrity. However, in some geologic environments, such as coarse gravel, where excessive loss of sealing materials may occur, or when grout may affect the water quality of nearby monitoring wells, clean sand or gravel in conjunction with regular materials can be used (Gordon, 1988; Kraemer et al., 1991).

Procedures

Planning

Careful review should be conducted prior to sealing monitoring wells. This may include:

- Review of records pertaining to well construction and repair or modifications.
- Review of all analytical chemical data for soil and ground water.
- Review of the hydrogeologic/geologic characteristics in the vicinity of the well.
- Current conditions of the well such as total depth, amount of siltation, etc.

¹ The information in this section is from Chapter 9 of the Ohio Environmental Protection Agency's "Technical Guidance Manual for Hydrogeologic Investigations and Ground Water Monitoring", 1995.

If a well is to be left in place, borehole geophysical techniques may be helpful in determining its integrity. This may include caliper logs to measure inside diameter; television logs to identify casing breaks, screen size, etc.; gamma logs to verify geologic information; cement bond logs to determine if the casing is firmly attached to the grout; flow logs to determine if vertical flow occurs within the casing; and hydraulic integrity tests to determine if the casing is intact (ASTM, 1993).

Prior to the sealing of monitoring wells, it is recommended that a work plan detailing the procedures/methods be submitted to the appropriate regulatory authority². The information should include:

- Reasons for sealing.
- Identification and location coordinates.
- Casing diameter and material.
- Screen material, length, and depth.
- Total depth.
- Geologic materials opposite well screen.
- Drilling log and construction diagrams.
- Type and concentrations of contaminants present³, if any.
- Procedure for disposal of any contaminated soil, well construction material, and water.
- Method for sealing.
- Type of sealing material.
- An estimation of the volume of sealing material needed.
- Measures to protect the health and safety of individuals.

Field Procedure

Monitoring wells have often been sealed by pulling the surface casing where possible, followed by pouring cement or bentonite into the hole. This procedure is inappropriate, especially if the construction of the well is unknown or the well intake spans more than one saturated zone. Incomplete seals may form due to bridging. Additionally, the procedure has little effect on the filter pack, which may allow communication between saturated zones.

The following basic procedure is recommended for sealing monitoring wells and boreholes. Steps 1 and 2 are not necessary for sealing exploratory boreholes. It should be understood that no single method and material are suitable for all situations. Site-specific characteristics may merit modifications or procedures not discussed below. Additional information can be found in the references listed.

1. Inspect the well and remove any obstacles (i.e., pumps, pressure lines, other debris, etc.) that may interfere with the placement and performance of the sealing material. If necessary, a camera survey can help to identify the depth and construction of the well if this information is not known. The outer protective casing should be removed.

2. Since the primary purpose of sealing is to eliminate vertical fluid movement, it is strongly recommended that the casing and screen be removed and the boring be overdrilled to remove the annular seal and filter pack, unless it can be determined that the original grout seal is intact. When the well is removed, there is less concern about channeling in the annular space or an inadequate casing/grout seal (Aller et al., 1991). The casing and well screen can be removed by pulling or bumping the casing, overdrilling around the casing using a hollow stem auger, or drilling out the well using a solid stem auger or rotary bit. The method used should depend on the type, length, and diameter of the casing, conditions of the annular seal, and site geology. Aller et al. (1991) and ASTM 5299-92 provided a discussion on various removal techniques. The borehole should be overdrilled using a bit with a diameter at least 1½ times greater than the original diameter of the borehole. Drilling should

² If a regulated entity is conducting a hydrogeologic investigation or a ground water monitoring program, a well sealing work plan should be submitted prior to initiating the program. In this situation, a separate workplan is not necessary.

³ If contamination was detected or suspected in the original well or boring, appropriate health and safety requirements should be followed.

be slightly deeper than the original depth to assure complete removal. To achieve an effective seal, the borehole should be cleared of any excess mud filtercake.

In some instances, such as when safety problems occur, or when dealing with large diameter wells, casing removal can be difficult. If the well construction is known, the screen and filter pack do not span more than one saturated zone, and circumstances prevent complete removal of casing and screen, then the following procedure can be used (based on Renz, 1989):

- a. The well can be filled with clean silica sand to one foot above the screen in the event that the screened area is adjacent to a highly permeable formation.
- b. One foot of bentonite pellets can be placed above the screen in a manner that prevents bridging (i.e., through a tremie pipe or by tamping after installation).
- c. The pellets should be hydrated.
- d. To allow the sealant to permeate and be effective, the casing should be perforated to one foot above the bentonite seal either by splitting it vertically (synthetic casing) or by making horizontal cuts every two feet with retractable blade (steel casing).

3. The borehole should be pressure grouted using a tremie pipe as the drilling stem is removed. The sealant should be applied in one continuous procedure to prevent segregation, dilution, and bridging (Aller et al., 1991). The pipe should be in constant contact with the sealant to prevent air pockets from forming. The borehole should be sealed from the bottom up to the frost line (approximately two to three feet from the surface). The overflowing grout should be regularly evaluated as it reaches the surface. When the observed material is similar to that being pumped in, this stage of the sealing is considered complete. Wells sealed in-situ should be sealed from the bottom up to approximately five feet from the surface.

4. The grout plug should be inspected 24 hours after installation to check for settling and grout should be added if needed. If the well is sealed in place, the casing should be cut off approximately five feet below ground level and a PVC or stainless steel cap should be emplaced. The boring should be grouted to within two to three feet from the surface with appropriate material. Monitoring wells sealed in place should be marked with a piece of metal to allow for location by a metal detector or magnetometer (Aller et al., 1991).

5. The remaining area above the plug should be completed in a manner that is compatible with the site. For example, its top can be covered with one to two feet of soil if vegetative growth is desired. If the area is to be surfaced, then the final seal can be completed with cement or concrete.

6. Proper sealing of monitoring wells should be documented and reported to the implementing regulatory agency managing the site. The information should include, at a minimum:

- Identification (e.g. registration number, location, owner, other features).
- Well construction details.
- Date, time, person responsible, and contractor/consultant performing the work.
- Authority under which the sealing was performed.
- Procedures and materials used.
- Method/procedures for disposal of any contaminated materials.

Additionally, Ohio Revised Code 1521.05(B) requires that a well sealing report be filed with the Ohio Department of Natural Resources (ODNR) on forms supplied by the Department. Figure A is an example of this form. It can be obtained from ODNR, Division of Water (614-265-6739).

Appendix B: Quality Assurance Project Plan (QAPP)

CDROM

QUALITY ASSURANCE PROJECT PLAN (QAPP)
FOR THE
REMEDIAL DESIGN / REMEDIAL ACTION
CHEMICAL RECOVERY SYSTEMS, INC. SITE

Prepared for
CRS Site RD/RA Performing Parties
Chemical Recovery Systems, Inc. (CRS) Site
Elyria, Ohio
September 2010

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139452

Intergovernmental Data Quality Task Force

Workbook for
Uniform Federal Policy for Quality Assurance
Project Plans

Evaluating, Assessing, and Documenting Environmental Data
Collection and Use Programs

Part 2A: UFP-QAPP Workbook



This Workbook supplements Part 1 of the UFP-QAPP, the UFP-QAPP Manual. Proper completion of these worksheets requires knowledge of the QAPP elements explained in the Manual.

Final
Version 1
March 2005

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QAPP Worksheet No. 1

Title and Approval Page

Site Name/Project Name: **CRS Site**
Site Location: **CRS Site, Elyria, Lorain County, Ohio**

Title: **QAPP**
Revision Number: 0
Revision Date: **9/20/10**
Page: 1 of 79

Quality Assurance Project Plan for the Chemical Recovery Systems, Inc. Site Remedial Design Activities

Document Title

United States Environmental Protection Agency, Region 5

Lead Organization

James R. Krebs, Brown and Caldwell

Preparer's Name and Organizational Affiliation

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20/09/10

Preparation Date (Day/Month/Year)

Brown and Caldwell Project Manager: _____



Signature

James A. Peeples, P.E., Brown and Caldwell

Brown and Caldwell Project QA Officer: _____



Signature

James R. Krebs P.E., Brown and Caldwell

USEPA – Remedial Project Manager: _____

Signature

Michelle Kerr, USEPA

Other Approval Signatures: _____

Signature

Printed Name/Title/Date

Document Control Number: _____

QAPP Worksheet No. 2

QAPP Identifying Information

Title: **QAPP**

Revision Number: **0**

Revision Date: **9/20/10**

Page: **2 of 79**

Site Name/Project Name: Chemical Recovery Systems, Inc. Site (CRS Site)

Site Location: 142 Locust Street, Elyria, Lorain County, Ohio

Site Number/Code: USEPA facility identification number - OHD 057001810

Operable Unit: N/A

Contractor Name: Brown and Caldwell

Contractor Number: N/A

Contract Title: N/A

Work Assignment Number: N/A

1. Identify guidance used to prepare QAPP:

Uniform Federal Policy for Implementing Quality Systems (EPA-505-F-03-001, Uniform Federal Policy for Quality Assurance Project Plans, Parts 1, 2, and 3 (EPA-505-B-04-900A, B, and C.

2. Identify regulatory program: _CERCLA, Remedial Design/Remedial Action ____

3. Identify approval entity: United States Environmental Protection Agency, Region 5

4. Indicate whether the QAPP is a generic or a project-specific QAPP. (circle one)

5. List dates of scoping sessions that were held: _8/1/10 through 9/20/10

6. List dates and titles of QAPP documents written for previous site work, if applicable:

Title:

Quality Assurance Project Plan, Revision II (Parsons, February 2003) _____

7. List organizational partners (stakeholders) and connection with lead organization:

- USEPA, Region 5
- Ohio EPA
- Chemical Recovery Solvents, Inc. RD/RA Settling Performing Defendants.

8. List data users: as listed above

9. If any required QAPP elements and required information are not applicable to the project, then circle the omitted QAPP elements and required information on the attached table. Provide an explanation for their exclusion below:

QAPP Worksheet No. 2 (continued)

QAPP Identifying Information

Title: **QAPP**
Revision Number: 0
Revision Date: **9/20/10**
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Required QAPP Element(s) and Corresponding QAPP Section(s)	Required Information	Cross-reference to Related Documents
Project Management and Objectives		
2.1 Title and Approval Page	- Title and Approval Page	Worksheet No. 1
2.2 Document Format and Table of Contents 2.2.1 Document Control Format 2.2.2 Document Control Numbering System 2.2.3 Table of Contents 2.2.4 QAPP Identifying Information	- Table of Contents - QAPP Identifying Information	Page ii in QAPP Worksheet Nos. 1, 2
2.3 Distribution List and Project Personnel Sign-Off Sheet 2.3.1 Distribution List 2.3.2 Project Personnel Sign-Off Sheet	- Distribution List - Project Personnel Sign-Off Sheet	Worksheet No. 3 Worksheet No. 4
2.4 Project Organization 2.4.1 Project Organizational Chart 2.4.2 Communication Pathways 2.4.3 Personnel Responsibilities and Qualifications 2.4.4 Special Training Requirements and Certification	- Project Organizational Chart - Communication Pathways - Personnel Responsibilities and Qualifications Table - Special Personnel Training Requirements Table	Worksheet No. 5 Worksheet No. 6 Worksheet No. 7 Worksheet No. 8
2.5 Project Planning/Problem Definition 2.5.1 Project Planning (Scoping) 2.5.2 Problem Definition, Site History, and Background	- Project Planning Session Documentation (including Data Needs tables) - Project Scoping Session Participants Sheet - Problem Definition, Site History, and Background - Site Maps (historical and present)	Worksheet No. 9 Worksheet No. 9 Worksheet No. 10,
2.6 Project Quality Objectives and Measurement Performance Criteria 2.6.1 Development of Project Quality Objectives Using the Systematic Planning Process 2.6.2 Measurement Performance Criteria	- Site-Specific PQOs - Measurement Performance Criteria Table	Worksheet No. 11 and Worksheet No. 12
2.7 Secondary Data Evaluation	- Sources of Secondary Data and Information - Secondary Data Criteria and Limitations Table	Worksheet No. 13 Worksheet No. 13
2.8 Project Overview and Schedule 2.8.1 Project Overview 2.8.2 Project Schedule	- Summary of Project Tasks - Reference Limits and Evaluation Table - Project Schedule/Timeline Table	Worksheet No. 14 Worksheet No. 15 Worksheet No. 16

QAPP Worksheet No. 2 (continued)

QAPP Identifying Information

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Required QAPP Element(s) and Corresponding QAPP Section(s)	Required Information	Cross-reference to Related Documents
Measurement/Data Acquisition		
3.1 Sampling Tasks 3.1.1 Sampling Process Design and Rationale 3.1.2 Sampling Procedures and Requirements 3.1.2.1 Sampling Collection Procedures 3.1.2.2 Sample Containers, Volume, and Preservation 3.1.2.3 Equipment/Sample Containers Cleaning and Decontamination Procedures 3.1.2.4 Field Equipment Calibration, Maintenance, Testing, and Inspection Procedures 3.1.2.5 Supply Inspection and Acceptance Procedures 3.1.2.6 Field Documentation Procedures	- Sampling Design and Rationale - Sample Location Map - Sampling Locations and Methods/ SOP Requirements Table - Analytical Methods/SOP Requirements Table - Field Quality Control Sample Summary Table - Sampling SOPs - Project Sampling SOP References Table - Field Equipment Calibration, Maintenance, Testing, and Inspection Table	Worksheet No. 17 Figures in the FSP, and RDWP Worksheet No. 18 Worksheet No. 23 Worksheet No. 20 Worksheet No. 18 Worksheet No. 23 Worksheet No. 20
3.2 Analytical Tasks 3.2.1 Analytical SOPs 3.2.2 Analytical Instrument Calibration Procedures 3.2.3 Analytical Instrument and Equipment Maintenance, Testing, and Inspection Procedures 3.2.4 Analytical Supply Inspection and Acceptance Procedures	- Analytical SOPs - Analytical SOP References Table - Analytical Instrument Calibration Table - Analytical Instrument and Equipment Maintenance, Testing, and Inspection Table	Attachment A to QAPP Worksheet No. 23 Worksheet No. 24 Worksheet No. 25
3.3 Sample Collection Documentation, Handling, Tracking, and Custody Procedures 3.3.1 Sample Collection Documentation 3.3.2 Sample Handling and Tracking System 3.3.3 Sample Custody	- Sample Collection Documentation Handling, Tracking, and Custody SOPs - Sample Container Identification - Sample Handling Flow Diagram - Example Chain-of-Custody Form and Seal	Worksheet No. 26 and Worksheet Nos 26 and 27
3.4 Quality Control Samples 3.4.1 Sampling Quality Control Samples 3.4.2 Analytical Quality Control Samples	- QC Samples Table - Screening/Confirmatory Analysis Decision Tree	Worksheet No. 28 Worksheet No. 28 and

QAPP Worksheet No. 2 (continued)

QAPP Identifying Information

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Required QAPP Element(s) and Corresponding QAPP Section(s)	Required Information	Cross-reference to Related Documents
3.5 Data Management Tasks 3.5.1 Project Documentation and Records 3.5.2 Data Package Deliverables 3.5.3 Data Reporting Formats 3.5.4 Data Handling and Management 3.5.5 Data Tracking and Control	- Project Documents and Records Table - Analytical Services Table - Data Management SOPs	Worksheet No. 29 Worksheet No. 20
Assessment/Oversight		
4.1 Assessments and Response Actions 4.1.1 Planned Assessments 4.1.2 Assessment Findings and Corrective Action Responses	- Assessments and Response Actions - Planned Project Assessments Table - Audit Checklists - Assessment Findings and Corrective Action Responses Table	Worksheet No. 31 Worksheet No. 31 Worksheet No. 32
4.2 QA Management Reports	- QA Management Reports Table	Worksheet No. 33
4.3 Final Project Report		Worksheet No. 33
Data Review		
5.1 Overview		
5.2 Data Review Steps 5.2.1 Step I: Verification 5.2.2 Step II: Validation 5.2.2.1 Step IIa Validation Activities 5.2.2.2 Step IIb Validation Activities 5.2.3 Step III: Usability Assessment 5.2.3.1 Data Limitations and Actions from Usability Assessment 5.2.3.2 Activities	- Verification (Step I) Process Table - Validation (Steps IIa and IIb) Process Table - Validation (Steps IIa and IIb) Summary Table - Usability Assessment	Worksheet No. 34 Worksheet No. 35 Worksheet No. 36 Worksheet No. 37
5.3 Streamlining Data Review 5.3.1 Data Review Steps To Be Streamlined 5.3.2 Criteria for Streamlining Data Review 5.3.3 Amounts and Types of Data Appropriate for Streamlining		

Distribution List

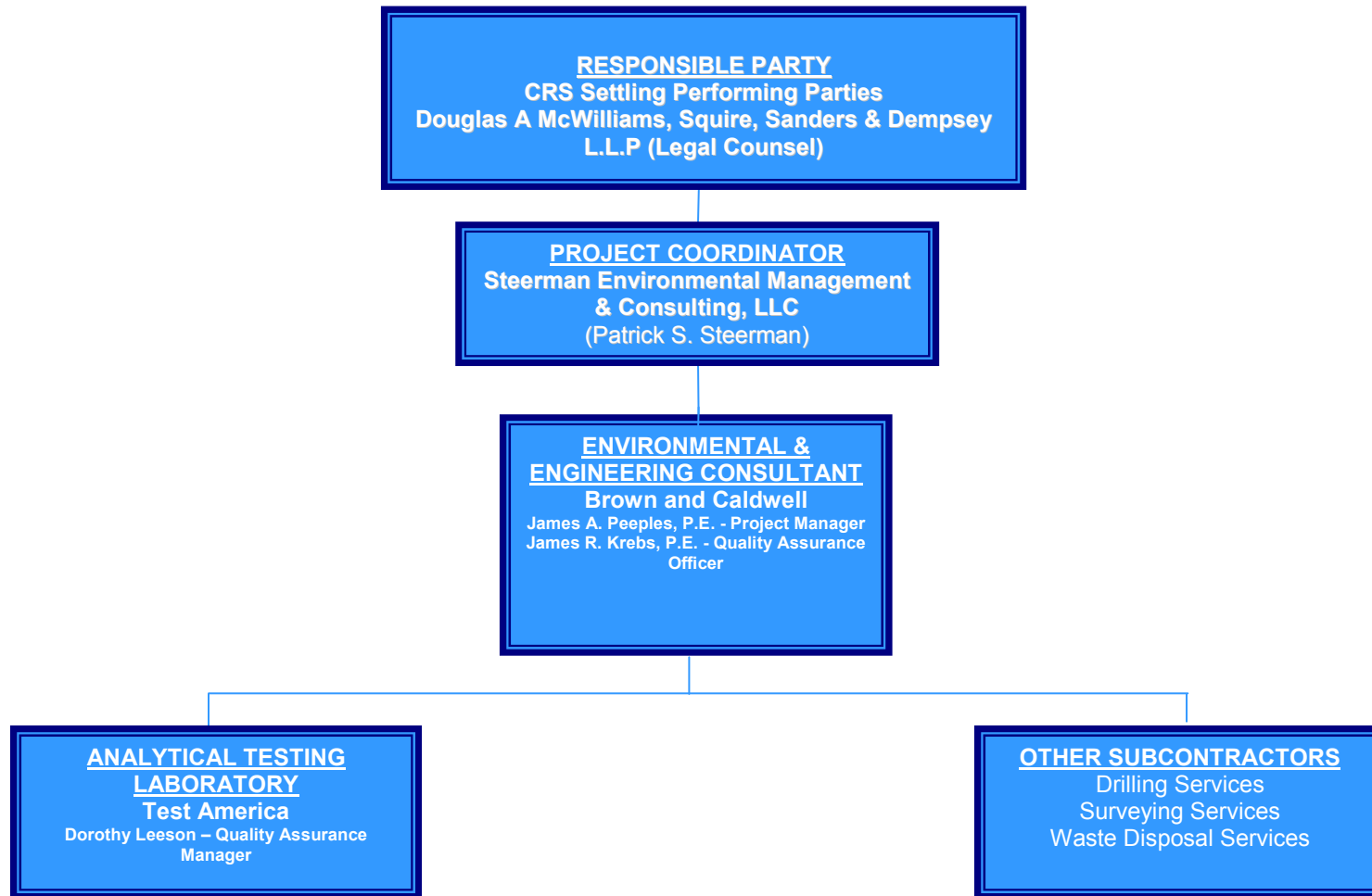
QAPP Recipients	Title	Organization	Telephone Number	Fax Number	E-mail Address	Document Control Number
Michelle Kerr	Project Manager/ Coordinator	USEPA	312-886-8961	312-697-2658	Kerr.Michelle@epamail.epa.gov	
Lawrence J. Antonelli	Project Coordinator	OEPA	330-963-1127	330-487-0769	larry.antonelli@epa.state.oh.us	
James A. Peeples, P.E.	Project Manager	Brown and Caldwell	614-410-6144	614-410-3088	jpeeples@brwncald.com	
James R. Krebs, P.E.	QA Officer	Brown and Caldwell	614-653-5474	614-410-3088	jkrebs@brwncald.com	
Brown And Caldwell Field Team	Various	Brown and Caldwell	Various	Various	Various	
CRS Performing Parties Group	Various	Various	Various	Various	Various	
Patrick S. Steerman	PRP Group's Project Coordinator	Steerman Environmental Management & Consulting, LLC	404-329-9006	404-329-9006	psteerman@charter.net	
Dorothy Leeson	Quality Assurance Manger	TestAmerica Laboratories, Inc.	330-497-9396	330-497-0772	dorothy.leeson@testamericainc.com	

Project Personnel Sign-Off Sheet

Organization: _____

Project Personnel	Title	Telephone Number	Signature	Date QAPP Read

Project Organizational Chart



Communication Pathways

Communication Drivers	Responsible Entity	Name	Phone Number	Procedure (Timing, Pathways, etc.)
Contact USEPA	Steerman Environmental Management & Consulting, LLC.	Patrick Steerman	404-329-9006	All written and most verbal from the consultants and contractors for the Group will be made through Mr. Steerman, unless otherwise directed by Mr. Steerman.
Point of Contact at USEPA	USEPA	Michelle Kerr	312-886-8961	Materials to be submitted to USEPA will be provided to the point of contact at USEPA.
Point of Contact at OEPA	OEPA	Lawrence J. Antonelli	330-963-1127	Materials to be submitted to OEPA will be provided to the point of contact at Ohio EPA.
Manage Project Phases	Brown and Caldwell	James Peeples	614-410-6144	Changes in scope and requests by USEPA or others will be provided by Patrick Steerman. Mr. Peeples will coordinate BC resources accordingly.
QAPP changes in the field	Brown And Caldwell Field Sampling Manager	James Krebs	614-653-5474	Field driven adjustments, or non-conformance, to the QAPP will be addressed through Mr. Krebs, and reported to Mr. Peeples.
Reporting Analytical Lab Quality Issues	TestAmerica	Alesia Danford	330-966-9783	Deviations in compliance with QA/QC will be reported to Mr. Peeples by Ms. Danford .
QAPP Amendments	Brown and Caldwell	James Krebs	614-653-5474	QAPP amendments, as necessary, will be initiated by Mr. Krebs, after authorized by Mr. Peeples and Mr. Steerman.

Personnel Responsibilities and Qualifications Table

Name	Title	Organizational Affiliation	Responsibilities	Education and Experience Qualifications
Michelle Kerr	Project Manager/ Coordinator	USEPA	USEPA Project Coordinator	
Lawrence J. Antonelli	Project Coordinator	OEPA	OEPA Project Coordinator	
Patrick S. Steerman	Project Coordinator	Steerman Environmental Management & Consulting, LLC	Project Coordinator	
James A. Peebles, P.E.	Project Manager, Supervising Engineer	Brown and Caldwell	Project Manager	B.S., Biology; M.S., Agricultural Engineering; 20 years experience
James R. Krebs, P.E.	Project Engineer III	Brown and Caldwell	QA Manager, Field Team Leader	B.S., Civil Engineering; 19 years experience
Scott Blanchard, P.G.	Geologist III	Brown and Caldwell	Health and Safety Officer	B.S., M.S. Geology; 19 years experience
Dorothy Leeson	QA Officer	TestAmerica	QA Officer	B.S. Chemistry, Ohio University, 25 years experience
Alesia Danford	Project Manager -	TestAmerica	Project Management	26 years experience; coursework Kent State

Special Personnel Training Requirements Table

Project Function	Specialized Training – Title or Description of Course	Training Providers	Training Date	Personnel/Groups Receiving Training	Personnel Titles/ Organizational Affiliation	Location of Training Records/Certificates¹
HAZWOPER	40-hour initial training as per 29 CFR 1910.120	Various certified out-sourced providers	Various	Field personnel, Project Manager, and other key staff	Various BC staff and drilling subcontractor field staff	BC corporate office, Walnut Creek, CA and BC's Columbus, OH office
HAZWOPER	8-hour annual refresher as per 29 CFR 1910.120	Certified in-house and out-sourced providers	Various	Field personnel, Project Manager, and other key staff	Various BC staff and drilling subcontractor field staff	BC corporate office, Walnut Creek, CA and BC's Columbus, OH office
HAZWOPER	CPR and first aid training as per 29 CFR 1910.120	Out-sourced to certified trainers	Various	Site-Safety Officer on site during fieldwork	Various BC field staff	BC corporate office, Walnut Creek, CA and BC's Columbus, OH office

¹If training records and/or certificates are on file elsewhere, document their location in this column. If training records and/or certificates do not exist or are not available, then this should be noted.

Project Scoping Session Participants Sheet

Project Name: Remedial Design Projected Date(s) of Sampling: 2010-2013 Project Manager: James Peeples				Site Name: CRS Site Site Location: Elyria, Lorain County, Ohio	
Date of Session: 8/1/10 through 9/15/10 Scoping Session Purpose: Define DQOs, Content/Status of RDWP and Develop HASP					
Name	Title	Affiliation	Phone No.	E-mail Address	Project Role
James Peeples	Project Manager/ Supervising Engineer	BC	614-410-6144	jpeeples@brwncaled.com	Project Manager
James Krebs	Project Engineer III	BC	614-653-5474	jkrebs@brwncaled.com	Field Team Leader, QAPP, FSP
Bryant Kiedrowski	Project Engineer III	BC	614-923-0853	bkiedrowski@brwncaled.com	HASP

Consensus Decisions:

- RDWP/QAPP, other appendices etc. for work activities for design of the remedy for the Site to be performed as set forth in the CD, ROD, and, SOW.
- Health and Safety Plan to be developed - project specific to the CRS Site.
- Selected TestAmerica as the analytical lab.

Comments/Decisions:

- Add a "List of Acronyms" page at the front of each document.
- Standardize nomenclature in the RDWP/appendices

Action Items: Complete RDWP, Appendices and associated documents for the Performing Parties review by September 15, 2010.

Problem Definition

DATA QUALITY OBJECTIVES (DQOs)

- The data quality objectives (DQOs) needs are established in the Remedial Design Work Plan to be submitted to the USEPA.

Project Quality Objectives/Systematic Planning Process Statements

Who will use the data?

- Data will be used by the CRS Performing Parties Group, its contractors, USEPA, and OEPA.

What will the data be used for?

- The data will be used to evaluate the aforementioned DQOs and to develop a RD that meets the requirements of the CD, SOW and ROD. The project Performance Standards are those described in the SOW;
- Analytical sensitivity must be adequate to detect and quantify the concentrations of each of the listed constituents to the concentrations of their respective action levels;
- The data will be used in the evaluation of Site impact extents, disposition of waste for disposal, documentation of contaminants left in place.

What types of data are required?

- Groundwater quality data are needed for the parameters, well locations, and monitoring frequency as stated in the FSP.
- Groundwater/LNAPL/DNAPL elevation data are needed from the wells and at the frequency as stated in the FSP.
- Soil/waste quality data are needed for the parameters and locations described in the FSP.
- Waste characterization data are needed for the parameters and wastes described in the FSP.
- Survey data are needed for the locations described in the FSP.

How good do the data need to be?

- 90 percent of the data from a given sampling or measurement event will be useable.
- A primary Measurement Performance Criterion is adequate analytical sensitivity to meet the Performance Standards listed on Worksheet No. 15

How much data are needed?

- The spatial distribution of the data is specified in the FSP.
- The temporal distribution of the data is specified in the FSP.
- The specific analytical parameters to be tested are specified in the FSP.

Project Quality Objectives/Systematic Planning Process Statements

How will the data be collected?

- The aqueous media samples (e.g., groundwater, surface water, etc.) destined for chemical analysis will be collected using the procedures specified in the FSP.
- The specified aqueous media samples will be analyzed by TestAmerica following SW846 analytical methodology as described in the RDWP, FSP and Additional Groundwater Studies Work Plan.
- Groundwater and LNAPL/DNAPL thickness and elevation data will be determined from depth to fluid field measurements using electronic water level meters and interface probes.
- The solid media samples (soil, waste, sediment, etc.) destined for chemical analysis will be collected using the procedures specified in the FSP.
- The specified solid media samples will be analyzed by TestAmerica following SW846 analytical methodology as described in the RDWP, FSP and Additional Groundwater Studies Work Plan.
- Survey data will be obtained by a licensed Ohio surveyor in accordance with the required horizontal and vertical accuracy.

Who will generate the data?

- Qualified personnel from BC will collect the environmental media samples.
- Qualified personnel from BC will perform the liquid level measurements.
- Qualified personnel from the designated surveying company will conduct the horizontal and vertical survey of sampling locations.

How will the data be reported?

- Field data will be recorded and reported as specified in the FSP.
- Laboratory analytical data will be reported to BC in two formats:
 1. Laboratory summary report including sample results, a case-narrative, and a QA summary report.
 2. Electronic data deliverable (EDD) of the aforementioned in a BC-specified format.
- Survey data will be reported to BC in both hard copy and electronic format, and will include the following data: the northing coordinate, the easting coordinate, and the elevation (MSL-mean sea level).
- Data will be reported to USEPA as appendices to the Remedial Design Report, with the data summarized in tables contained within the body of the report. An electronic version of the complete report, in PDF format, will also be provided.

Project Quality Objectives/Systematic Planning Process Statements

How will the data be archived?

- Aforementioned electronic files will be maintained in their native formats on a server located in BC's Columbus, Ohio office.
- Tape backups of the files on the servers are made periodically which are stored at an off-site location for ten years.
- A paper copy of the complete Remedial Design Report will be maintained either at the BC office in Columbus, Ohio or an off-site document repository for a time period of 10 years following USEPA's approval of the work, as specified in the Consent Decree.

Measurement Performance Criteria Table

Matrix	Aqueous				
Analytical Group	VOCs				
Concentration Level	Low				
Sampling Procedure¹	Analytical Method/SOP²	Data Quality Indicators (DQIs)	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
Groundwater Sampling	SW-846 8260 B	Precision/ Laboratory	RPD < 30% or the laboratory-specified recovery limits	Laboratory Duplicate	A
Groundwater Sampling	SW-846 8260 B	Precision/Sample Collection	RPD < 30% or the laboratory-specified recovery limits	Field Duplicate	S & A
Groundwater Sampling	SW-846 8260 B	Accuracy/Bias	RPD < 30% or the laboratory-specified recovery limits	MS/MSD	S & A
Groundwater Sampling	SW-846 8260 B	Accuracy/Bias	RPD < 30% or the laboratory-specified range	Laboratory Control Sample	A
Groundwater Sampling	SW-846 8260 B	Accuracy/Bias	Percent recovery within laboratory-specified recovery limits: (DBF 73-122%) (1,2-DCA-d4 61-128%) (Toluene-d8 76-110%) (4-BFB 74-116)	Surrogate	A
Groundwater Sampling	SW-846 8260 B	Accuracy/ Lab contamination	No Target Compounds>RL; no common lab contaminants >5XRL.	Method Blank	A
Groundwater Sampling	SW-846 8260 B	Accuracy/ Transport contamination	No Target Compounds>RL; no common lab contaminants >5XRL.	Trip Blank	A
Groundwater Sampling	SW-846 8260 B	Accuracy/ Field contamination	No Target Compounds>RL; no common lab contaminants >5XRL.	Field Blank	S & A

Measurement Performance Criteria Table

Matrix	Aqueous				
Analytical Group	VOCs				
Concentration Level	Low				
Sampling Procedure¹	Analytical Method/SOP²	Data Quality Indicators (DQIs)	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
Groundwater Sampling	SW-846 8260 B	Accuracy/ Holding Time	< 14 days until analysis	Reported sample data	A
Groundwater Sampling	SW-846 8260 B	Completeness	>90% field samples >90% lab analyses	Reported sample data	S & A
Groundwater Sampling	SW-846 8260 B	Representativeness	RPD <30% for detected data, ND comparison	Field Duplicate	S & A
Groundwater Sampling	SW-846 8260 B	Sensitivity	QL ≤ Associated Performance Standards	Reported sample data	A

¹ Reference number from QAPP Worksheet No. 21.² Reference number from QAPP Worksheet No. 23.

Measurement Performance Criteria Table

Matrix	Soil				
Analytical Group	VOCs				
Concentration Level	Low				
Sampling Procedure	Analytical Method/SOP²	Data Quality Indicators (DQIs)	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
Soil Sampling	SW-846 8260 B	Precision/Laboratory	RPD < 30% or the laboratory-specified recovery limits	Laboratory Duplicate	A
Soil Sampling	SW-846 8260 B	Precision/Sample Collection	RPD < 30% or the laboratory-specified recovery limits	Field Duplicate	S & A
Soil Sampling	SW-846 8260 B	Accuracy/Bias	RPD < 30% or the laboratory-specified recovery limits	MS/MSD	S & A
Soil Sampling	SW-846 8260 B	Accuracy/Bias	RPD < 30% or the laboratory-specified range	Laboratory Control Sample	A
Soil Sampling	SW-846 8260 B	Accuracy/Bias	Percent recovery within laboratory-specified recovery limits: (DBF 59-138%) (1,2-DCA-d4 61-130%) (Toluene-d8 60-143%) (4-BFB 47-158)	Surrogate	A
Soil Sampling	SW-846 8260 B	Accuracy/ Lab contamination	No Target Compounds>RL; no common lab contaminants >5XRL.	Method Blank	A
Soil Sampling	SW-846 8260 B	Accuracy/ Transport contamination	No Target Compounds>RL; no common lab contaminants >5XRL.	Trip Blank	A
Soil Sampling	SW-846 8260 B	Accuracy/ Field contamination	No Target Compounds>RL; no common lab contaminants >5XRL.	Field Blank	S & A
Soil Sampling	SW-846 8260 B	Accuracy/ Holding Time	< 14 days until analysis	Reported sample data	A
Soil Sampling	SW-846 8260 B	Completeness	>90% field samples >90% lab analyses	Reported sample data	S & A

Measurement Performance Criteria Table

Matrix	Soil				
Analytical Group	VOCs				
Concentration Level	Low				
Sampling Procedure	Analytical Method/SOP²	Data Quality Indicators (DQIs)	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
Soil Sampling	SW-846 8260 B	Representativeness	RPD <30% for detected data, ND comparison	Field Duplicate	S & A
Soil Sampling	SW-846 8260 B	Sensitivity	QL ≤ Associated Performance Standards	Reported sample data	A

¹ Reference number from QAPP Worksheet No. 21.² Reference number from QAPP Worksheet No. 23.

Measurement Performance Criteria Table

Matrix	Aqueous				
Analytical Group	SVOCs				
Concentration Level	Standard				
Sampling Procedure	Analytical Method/SOP²	Data Quality Indicators (DQIs)	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
Groundwater Sampling	SW-846 8270C	Precision/Laboratory	RPD <30%	Laboratory Duplicate	A
Groundwater Sampling	SW-846 8270C	Precision/Sample Collection	RPD <30%	Field Duplicate	S & A
Groundwater Sampling	SW-846 8270C	Accuracy/Bias	RPD < 30% or the laboratory-specified recovery limits	MS/MSD	S & A
Groundwater Sampling	SW-846 8270C	Accuracy/Bias	RPD < 30% or the laboratory-specified range	Laboratory Control Sample	A
Groundwater Sampling	SW-846 8270C	Accuracy/Bias	Percent recovery within laboratory-specified recovery limits: (2-FBP 28-110%) (2-FP 10-110%) (246-TBP 22-120%) (NB-d5 27-111%) (Phenol-d5 10-110%) (TP-d14 37-119%)	Surrogate	A
Groundwater Sampling	SW-846 8270C	Accuracy/ Lab contamination	No Target Compounds>RL; no common lab contaminants >5xRL	Method Blank	A
Groundwater Sampling	SW-846 8270C	Accuracy/ Transport contamination	No Target Compounds>RL; no common lab contaminants >5xRL	Trip Blank	A
Groundwater Sampling	SW-846 8270C	Accuracy/ Field contamination	No Target Compounds>RL; no common lab contaminants >5xRL	Field Blank	S & A
Groundwater Sampling	SW-846 8270C	Accuracy/ Holding Time	< 14 days until extraction; 40 to analysis	Reported sample data	A
Groundwater Sampling	SW-846 8270C	Completeness	>90% field samples >90% lab analyses	Reported sample data	S & A

Measurement Performance Criteria Table

Matrix	Aqueous				
Analytical Group	SVOCs				
Concentration Level	Low				
Sampling Procedure	Analytical Method/SOP²	Data Quality Indicators (DQIs)	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
Groundwater Sampling	SW-846 8270C	Representativeness	RPD <30% for detected data, ND comparison	Field Duplicate	S & A
Groundwater Sampling	SW-846 8270C	Sensitivity	QL ≤ Associated Performance Standards	Reported sample data	A

Measurement Performance Criteria Table

Matrix	Soil				
Analytical Group	SVOCs				
Concentration Level	Standard				
Sampling Procedure	Analytical Method/SOP²	Data Quality Indicators (DQIs)	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
Soil Sampling	SW-846 8270 C	Precision/Laboratory	RPD <30%	Laboratory Duplicate	A
Soil Sampling	SW-846 8270C	Precision/Sample Collection	RPD <30%	Field Duplicate	S & A
Soil Sampling	SW-846 8270C	Accuracy/Bias	RPD < 30% or the laboratory-specified recovery limits	MS/MSD	S & A
Soil Sampling	SW-846 8270C	Accuracy/Bias	RPD < 30% or the laboratory-specified range	Laboratory Control Sample	A
Soil Sampling	SW-846 8270C	Accuracy/Bias	Percent recovery within laboratory-specified recovery limits: (2-FBP 34-110%) (2-FP 26-110%) (246-TBP 10-118%) (NB-d5 24-225%) (Phenol-d5 28-110%) (TP-d14 41-119%)	Surrogate	A
Soil Sampling	SW-846 8270C	Accuracy/ Lab contamination	No Target Compounds>RL; no common lab contaminants >5xRL	Method Blank	A
Soil Sampling	SW-846 8270C	Accuracy/ Transport contamination	No Target Compounds>RL; no common lab contaminants >5xRL	Trip Blank	A
Soil Sampling	SW-846 8270C	Accuracy/ Field contamination	No Target Compounds>RL; no common lab contaminants >5xRL	Field Blank	S & A
Soil Sampling	SW-846 8270C	Accuracy/ Holding Time	< 7 days until extraction; 40 to analysis	Reported sample data	A
Groundwater Sampling	SW-846 8270C	Completeness	>90% field samples >90% lab analyses	Reported sample data	S & A

Measurement Performance Criteria Table

Matrix	Soil				
Analytical Group	SVOCs				
Concentration Level	Low				
Sampling Procedure¹	Analytical Method/SOP²	Data Quality Indicators (DQIs)	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
Groundwater Sampling	SW-846 8270C	Representativeness	RPD <30% for detected data, ND comparison	Field Duplicate	S & A
Groundwater Sampling	SW-846 8270C	Sensitivity	QL ≤ Associated Performance Standards	Reported sample data	A

Measurement Performance Criteria Table

Matrix	Water				
Analytical Group	PCBs				
Concentration Level	Standard				
Sampling Procedure¹	Analytical Method/SOP²	Data Quality Indicators (DQIs)	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
Groundwater Sampling	SW-846 8082	Precision/Laboratory	RPD < 30%	Laboratory Duplicate	A
Groundwater Sampling	SW-846 8082	Precision/Sample Collection	RPD < 30%	Field Duplicate	S & A
Groundwater Sampling	SW-846 8082	Accuracy/Bias	RPD < 30% or the laboratory-specified recovery limits	MS/MSD	S & A
Groundwater Sampling	SW-846 8082	Accuracy/Bias	RPD < 30% or the laboratory-specified range	Laboratory Control Sample	A
Groundwater Sampling	SW-846 8082	Accuracy/Bias	Percent recovery within laboratory-specified recovery limits: (DSBP 10-199%) (TCMX 10-196%)	Surrogate	A
Groundwater Sampling	SW-846 8082	Accuracy/Lab contamination	No Target Compounds>RL	Method Blank	A
Groundwater Sampling	SW-846 8082	Accuracy/Transport contamination	No Target Compounds>RL	Trip Blank	A
Groundwater Sampling	SW-846 8082	Accuracy/Field contamination	No Target Compounds>RL	Field Blank	S & A
Groundwater Sampling	SW-846 8082	Accuracy/Holding Time	< 7 days until extraction; 40 to analysis	Reported sample data	A
Groundwater Sampling	SW-846 8082	Completeness	>90% field samples >90% lab analyses	Reported sample data	S & A

Measurement Performance Criteria Table

Matrix	Water				
Analytical Group	PCBs				
Concentration Level	Standard				
Sampling Procedure¹	Analytical Method/SOP²	Data Quality Indicators (DQIs)	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
Groundwater Sampling	SW-846 8082	Representativeness	RPD <30% for detected data, ND comparison	Field Duplicate	S & A
Groundwater Sampling	SW-846 8082	Sensitivity	QL ≤ Associated Performance Standards	Reported sample data	A

Measurement Performance Criteria Table

Matrix	Soil				
Analytical Group	PCBs				
Concentration Level	Standard				
Sampling Procedure	Analytical Method/SOP²	Data Quality Indicators (DQIs)	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
Soil Sampling	SW-846 8082	Precision/ Laboratory	RPD <30%	Laboratory Duplicate	A
Soil Sampling	SW-846 8082	Precision/Sample Collection	RPD <30%	Field Duplicate	S & A
Soil Sampling	SW-846 8082	Accuracy/Bias	RPD < 30% or the laboratory- specified recovery limits	MS/MSD	S & A
Soil Sampling	SW-846 8082	Accuracy/Bias	RPD < 30% or the laboratory- specified range	Laboratory Control Sample	A
Soil Sampling	SW-846 8082	Accuracy/Bias	Percent recovery within laboratory-specified recovery limits: (DSBP 10-127%) (TCMX 27 -130%)	Surrogate	A
Soil Sampling	SW-846 8082	Accuracy/ Lab contamination	No Target Compounds>RL	Method Blank	A
Soil Sampling	SW-846 8082B	Accuracy/ Transport contamination	No Target Compounds>RL	Trip Blank	A
Soil Sampling	SW-846 8082	Accuracy/ Field contamination	No Target Compounds>RL	Field Blank	S & A
Soil Sampling	SW-846 8082	Accuracy/ Holding Time	< 14 days until extraction; 40 to analysis	Reported sample data	A
Soil Sampling	SW-846 8082	Completeness	>90% field samples >90% lab analyses	Reported sample data	S & A

Measurement Performance Criteria Table

Matrix	Aqueous				
Analytical Group	PCBs				
Concentration Level	Low				
Sampling Procedure	Analytical Method/SOP²	Data Quality Indicators (DQIs)	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
Groundwater Sampling	SW-846 8082	Representativeness	RPD <30% for detected data, ND comparison	Field Duplicate	S & A
Groundwater Sampling	SW-846 8082	Sensitivity	QL ≤ Associated Performance Standards	Reported sample data	A

Measurement Performance Criteria Table

Matrix	Aqueous				
Analytical Group	Metals				
Concentration Level	Standard				
Sampling Procedure	Analytical Method/SOP²	Data Quality Indicators (DQIs)	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
Groundwater Sampling	SW-846 6010B/7470A	Precision/Laboratory	RPD <20%	Laboratory Duplicate	A
Groundwater Sampling	SW-846 6010B/7470A	Precision/Sample Collection	RPD <20%	Field Duplicate	S & A
Groundwater Sampling	SW-846 6010B/7470A	Accuracy/Bias	RPD < 20%	MS/MSD	S & A
Groundwater Sampling	SW-846 6010B/7470A	Accuracy/Bias	RPD < 20%	Laboratory Control Sample	A
Groundwater Sampling	SW-846 6010B/7470A	Accuracy/Lab contamination	No target analytes > RL For common laboratory contaminants, no analytes >2x RL.. If MB is biased high and associated samples are below the RL or 20X the blank the data is accepted.	Method Blank	A
Groundwater Sampling	SW-846 6010B/7470A	Accuracy/Transport contamination	No Target Compounds>RL	Trip Blank	A
Groundwater Sampling	SW-846 6010B/7470A	Accuracy/Field contamination	No Target Compounds>RL	Field Blank	S & A
Groundwater Sampling	SW-846 6010B/7470A	Accuracy/Holding Time	180 Days / Hg in 28 days	Reported sample data	A
Groundwater Sampling	SW-846 6010B/7470A	Completeness	>90% field samples >90% lab analyses	Reported sample data	S & A

Measurement Performance Criteria Table

Matrix	Aqueous				
Analytical Group	Metals				
Concentration Level	Standard				
Sampling Procedure	Analytical Method/SOP²	Data Quality Indicators (DQIs)	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
Groundwater Sampling	SW-846 6010B/7470A	Representativeness	RPD <20% for detected data, ND comparison	Field Duplicate	S & A
Groundwater Sampling	SW-846 6010B/7470A	Sensitivity	QL ≤ Associated Performance Standards	Reported sample data	A

Measurement Performance Criteria Table

Matrix	Soil				
Analytical Group	Metals				
Concentration Level	Standard				
Sampling Procedure	Analytical Method/SOP²	Data Quality Indicators (DQIs)	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
Soil Sampling	SW-846 6010B/7470A	Precision/Laboratory	RPD <20%	Laboratory Duplicate	A
Soil Sampling	SW-846 6010B/7470A	Precision/Sample Collection	RPD <20%	Field Duplicate	S & A
Soil Sampling	SW-846 6010B/7470A	Accuracy/Bias	RPD < 20%	MS/MSD	S & A
Soil Sampling	SW-846 6010B/7470A	Accuracy/Bias	RPD < 20%	Laboratory Control Sample	A
Soil Sampling	SW-846 6010B/7470A	Accuracy/ Lab contamination	No target analytes > RL For common laboratory contaminants, no analytes >2x RL.. If MB is biased high and associated samples are below the RL or 20X the blank the data is accepted.	Method Blank	A
Soil Sampling	SW-846 6010B/7470A	Accuracy/ Transport contamination	No Target Compounds>RL	Trip Blank	A
Soil Sampling	SW-846 6010B/7470A	Accuracy/ Field contamination	No Target Compounds>RL	Field Blank	S & A
Soil Sampling	SW-846 6010B/7470A	Accuracy/ Holding Time	180 Days / Hg in 28 days	Reported sample data	A
Soil Sampling	SW-846 6010B/7470A	Completeness	>90% field samples >90% lab analyses	Reported sample data	S & A

Measurement Performance Criteria Table

Matrix	Soil				
Analytical Group	Metals				
Concentration Level	Standard				
Sampling Procedure	Analytical Method/SOP²	Data Quality Indicators (DQIs)	Measurement Performance Criteria	QC Sample and/or Activity Used to Assess Measurement Performance	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
Soil Sampling	SW-846 6010B/7470A	Representativeness	RPD <20% for detected data, ND comparison	Field Duplicate	S & A
Soil Sampling	SW-846 6010B/7470A	Sensitivity	QL ≤ Associated Performance Standards	Reported sample data	A

Secondary Data Criteria and Limitations Table

Secondary Data	Data Source (Originating Organization, Report Title, and Date)	Data Generator(s) (Originating Org., Data Types, Data Generation/Collection Dates)	How Data Will Be Used	Limitations on Data Use
Analytical data contained in the 2006 RI/FS Report prepared by Parsons.	RI/FS Reports, Revision 3 (Parsons, 2006)	Parsons collected data from 2003 to 2005	Data were used to evaluate remedial alternatives for the Site.	Data are used as reference.

Summary of Project Tasks

Field Sampling Tasks:

- Liquid level measurements.
- Collection of groundwater samples.
- Collection of soil samples.

Analysis Tasks:

- Environmental media samples will be subjected to analytical testing as needed.

Quality Control Tasks:

- Collect field duplicates, trip blanks, field blanks, and MS/MSD samples as appropriate.

Secondary Data:

- See Worksheet No. 13

Data Management Tasks:

- BC will manage the analytical data in data spreadsheets and/or a relational database.

Documentation and Records:

- Records will be prepared while sampling in the form of field logbook entries and completion of field forms, as appropriate.
- Chain-of-custody forms will be maintained.
- Data documentation and reporting by the laboratories will be in accordance with the relevant ASTM methods, laboratory SOPs, and QA Manuals.

Data Deliverables:

- Analytical data will be provided as electronic data deliverable (EDD) and data summary reports completed by TestAmerica.

Field Data Review;

- Field data review records reviewed for completeness and accuracy within one week after sample collection.

Data Review Tasks:

- Verification of data completeness.
- Review of samples data reports and QA summary reports to verify compliance with the MPCs on Worksheet No. 12.

Summary of Project Tasks

Data Reporting:

- Paper copies of laboratory summary report and QA report.
- EDD for analytical data from TestAmerica.
- Summary tables and figures in reports to USEPA, as well as paper copy of the raw data.

Reference Limits and Evaluation Table

Matrix: Soil Analytical Group: VOCs Concentration Level: Low					
Analyte	CAS Number	Project Action Limit ¹ (mg/kg)	Project Quantitation Limit (mg/kg)	Achievable Laboratory Limits (mg/kg)	
				MDL	RL
1,1,2,2-Tetrachlorethane	630-20-6	0.930	.005	0.00034	.005
1,1,2-Trichloroethane	79-00-5	1.6	.005	0.00039	.005
1,2 Dichloroethane	107-06-2	0.600	.005	0.00034	.005
1,2-Dichloropropane	78-87-5	0.740	.005	0.00069	.005
Benzene	71-43-2	1.3	.005	0.00023	.005
Bromodichloromethane	75-27-4	1.8	.005	0.00028	.005
Bromomethane	74-83-9	13	.005	0.00054	.005
Carbon Tetrachloride	56-23-5	0.550	.005	0.00037	.005
Chloroethane	75-00-3	6.5	.005	0.00086	.005
Chloroform	67-66-3	12	.005	0.00029	.005
Chloromethane	74-87-3	2.6	.005	0.00041	.005
Dibromochloromethane	124-48-1	2.6	.005	0.00055	.005
Ethylbenzene	100-41-4	20	.005	0.00026	.005
Methylene Chloride	75-09-2	21	.005	0.00067	.005
Tetrachloroethene (PCE)	127-18-4	3.4	.005	0.00052	.005
Trichloroethene (TCE)	79-01-6	0.110	.005	0.00042	.005
Vinyl Chloride	75-01-4	0.750	.005	0.00039	.005
Xylenes (total)	1330-207	420	.010	0.00067	.010

MDL = Minimum detection limit

RL = Reporting limit

1 = Based on Project Action Limits defined in the RI/FS and ROD

Reference Limits and Evaluation Table

Matrix: Soil Analytical Group: SVOCs Concentration Level: Low					
Analyte	CAS Number	Project Action Limit ¹ (mg/kg)	Project Quantitation Limit (mg/kg)	Achievable Laboratory Limits (mg/kg)	
				MDL	RL
1,3-Dichlorobenzene	541-73-1	63	0.05	0.011	0.05
1,4-Dichlorobenzene	106-46-7	7.9	0.05	0.02	0.05
2,4,6-Trichlorophenol	88-06-2	62	0.15	0.08	0.15
2-Nitroaniline	88-74-4	18	0.2	0.0091	0.2
3,3-Dichlorobenzidine	91-94-1	3.8	0.1	0.018	0.1
Benzo (a) anthracene	56-55-3	2.1	0.0067	0.0033	0.0067
Benzo (a) pyrene	50-32-8	0.210	0.0067	0.0033	0.0067
Benzo (b) fluoranthene	205-99-2	2.1	0.0067	0.0033	0.0067
Benzo (k) fluoranthene	207-08-9	21	0.0067	0.0033	0.0067
Bis (2-Chloroethyl) ether	111-44-4	0.550	0.1	0.002	0.1
Bis (2-Ethylhexyl) phthalate	117-81-7	120	0.05	0.019	0.05
Dibenzo (a,h) anthracene	53-70-3	0.210	0.0067	0.0033	0.0067
Hexachlorobenzene	118-74-1	1.1	0.0067	0.0021	0.0067
Hexachlorobutadiene	87-68-3	22	0.05	0.027	0.05
Indeno (1,2,3-cd) pyrene	193-39-5	2.1	0.0067	0.0033	0.0067
N-Nitrosodi-n-propylamine	621-64-7	0.250	0.05	0.027	0.05
Pentachlorophenol	87-86-5	9	0.15	0.08	0.15

MDL = Minimum detection limit

RL = Reporting limit

1 = Based on Project Action Limits defined in the RI/FS and ROD

Reference Limits and Evaluation Table

Matrix: Soil					
Analytical Group: TAL Metals					
Concentration Level: Low					
Analyte	CAS Number	Project Action Limit ¹ (mg/kg)	Project Quantitation Limit (mg/kg)	Achievable Laboratory Limits (mg/kg)	
				MDL	RL
Antimony	7440-36-0	410	1	0.39	1
Arsenic	7440-38-2	1.6	1	0.3	1
Iron	7439-89-6	100,000	10	4.9	10
Lead	7439-92-1	750	0.3	0.19	0.3

Matrix: Soil					
Analytical Group: PCBs					
Concentration Level: Low					
Analyte	CAS Number	Project Action Limit ¹ (mg/kg)	Project Quantitation Limit (mg/kg)	Achievable Laboratory Limits (mg/kg)	
				MDL	RL
Aroclor-1221	11104-28-2	0.74	0.033	0.016	0.033
Aroclor-1232	11141-16-5	0.74	0.033	0.014	0.033
Aroclor-1242	53469-21-9	0.74	0.033	0.013	0.033
Aroclor-1248	12672-29-6	0.74	0.033	0.017	0.033
Aroclor-1254	11097-69-1	0.74	0.033	0.017	0.033
Aroclor-1260	11096-82-5	0.74	0.033	0.017	0.033

MDL = Minimum detection limit

RL = Reporting limit

1 = Based on Project Action Limits defined in the RI/FS and ROD

Reference Limits and Evaluation Table

Matrix: Groundwater Analytical Group: VOCs Concentration Level: Low					
Analyte	CAS Number	Project Action Limit ¹ (µg/l)	Project Quantitation Limit (µg/l)	Achievable Laboratory Limits (µg/l)	
				MDL	RL
1,1,1-Trichlorethane	71-55-6	200	1	0.22	1
1,1,2,2-Tetrachlorethane	79-34-5	0.055	1	0.18	1
1,1,2-Trichloroethane	79-00-5	5	1	0.27	1
1,1-Dichloroethane	75-34-3	810	1	0.15	1
1,1-Dichloroethene	75-35-4	7	1	0.19	1
1,2 Dichloroethane	107-06-2	5	1	0.22	1
1,2-Dichloropropane	78-87-5	5	1	0.18	1
Acetone	67-64-1	610	10	1.1	10
Benzene	71-43-2	5	1	0.13	1
Bromodichloromethane	75-27-4	0.18	1	0.15	1
Bromoform	75-25-2	8.5	1	0.64	1
Bromomethane	74-83-9	8.7	1	0.41	1
Carbon Disulfide	75-15-0	1000	1	0.13	1
Carbon Tetrachloride	56-23-5	5	1	0.13	1
Chlorobenzene	108-90-7	100	1	0.15	1
Chloroethane	75-00-3	4.6	1	0.29	1
Chloroform	67-66-3	6.2	1	0.16	1
Chloromethane	74-87-3	1.5	1	0.3	1
cis-1,2-Dichloroethene	156-59-2	70	1	0.17	1
Dibromochloromethane	124-48-1	0.13	1	0.18	1
Ethylbenzene	100-41-4	700	1	0.17	1
Methylene Chloride	75-09-2	4.3	1	0.33	1
Styrene	100-42-5	1600	1	0.11	1
Tetrachloroethene (PCE)	127-18-4	5	1	0.29	1

Reference Limits and Evaluation Table

Matrix: Groundwater					
Analytical Group: VOCs					
Concentration Level: Low					
Analyte	CAS Number	Project Action Limit ¹ (µg/l)	Project Quantitation Limit (µg/l)	Achievable Laboratory Limits (µg/l)	
				MDL	RL
Toluene	108-88-3	1000	1	0.13	1
Trans-1,2-Dichloroethene	156-60-5	100	1	0.19	1
Trichloroethene (TCE)	79-01-6	5	1	0.17	1
Vinyl Chloride	75-01-4	2	1	0.22	1
Xylenes (total)	1330-20-7	10000	2	0.28	2

MDL = Minimum detection limit

RL = Reporting Limit

1 = Based on the MCLs, SMCLs, and Risk-Based Preliminary Remediation Goals from the RI/FS and ROD

Reference Limits and Evaluation Table

Matrix: Groundwater Analytical Group: SVOCs Concentration Level: Low					
Analyte	CAS Number	Project Action Limit ¹ (µg/l)	Project Quantitation Limit (µg/l)	Achievable Laboratory Limits (µg/l)	
				MDL	RL
1,2,4-Trichlorobenzene	120-82-1	70	1	0.24	1
1,2-Dichlorobenzene	95-50-1	370	1	0.29	1
1,3-Dichlorobenzene	541-73-1	5.5	1	0.8	1
1,4-Dichlorobenzene	106-46-7	0.5	1	0.34	1
2,4,6-Trichlorophenol	88-06-2	3.6	5	0.8	5
2,4-Dichlorophenol	120-83-2	110	2	0.8	2
2,4-Dimethylphenol	105-67-9	730	2	0.8	2
2,4-Dinitrophenol	51-28-5	73	5	2.4	5
2,4-Dinitrotoluene	121-14-2	73	5	0.27	5
2,6-Dinitrotoluene	606-20-2	36	5	0.8	5
2-Chloronaphthalene	91-58-7	490	1	0.1	1
2-Chlorophenol	95-57-8	30	1	0.29	1
2-Methylphenol	95-48-7	1800	1	0.8	1
2-Nitroaniline	88-74-4	1	2	0.8	2
3,3-Dichlorobenzidine	91-94-1	0.15	5	0.37	5
4-Chloroaniline	106-47-8	150	2	0.8	2
4-Methylphenol	8001-28-3	180	1	0.8	1
Acenaphthene	83-32-9	370	0.2	0.1	0.2
Benzo (a) anthracene	56-55-3	0.092	0.2	0.1	0.2
Benzo (a) pyrene	50-32-8	0.2	0.2	0.1	0.2
Benzo (b) fluoranthene	205-99-2	0.092	0.2	0.1	0.2
Benzo (k) fluoranthene	207-08-9	0.92	0.2	0.1	0.2
Bis (2-Chloroethyl) ether	111-44-4	0.0098	1	0.1	1

Reference Limits and Evaluation Table

Matrix: Groundwater Analytical Group: SVOCs Concentration Level: Low					
Analyte	CAS Number	Project Action Limit ¹ (µg/l)	Project Quantitation Limit (µg/l)	Achievable Laboratory Limits (µg/l)	
				MDL	RL
Carbazole	86-74-8	3.4	1	0.28	1
Chrysene	218-01-9	9.2	0.2	0.1	0.2
Dibenzo (a,h) anthracene	53-70-3	0.0092	0.2	0.1	0.2
Dibenzofuran	132-64-9	24	1	0.1	1
Di-n-octyl phthalate	117-84-0	1500	1	0.8	1
Fluoranthene	206-44-0	1500	0.2	0.1	0.2
Fluorene	86-73-7	240	0.2	0.1	0.2
Hexachlorobenzene	118-74-1	1	0.2	0.1	0.2
Hexachlorobutadiene	87-68-3	0.86	1	0.27	1
Hexachlorocyclopentadiene	77-47-4	50	10	0.8	10
Hexachloroethane	67-72-1	4.8	1	0.8	1
Indeno (1,2,3-cd) pyrene	193-39-5	0.092	0.2	0.1	0.2
Isophorone	78-59-1	71	1	0.27	1
Naphthalene	91-20-3	6.2	0.2	0.1	0.2
Nitrobenzene	98-95-3	3.4	1	0.04	1
N-Nitrosodi-n-propylamine	621-64-7	0.0096	1	0.8	1
N-Nitrosodiphenylamine	86-30-6	14	1	0.31	1
Pyrene	129-00-0	180	0.2	0.1	0.2

MDL = Minimum detection limit

RL = Reporting limit

1 = Based on the MCLs, SMCLs, and Risk-Based Preliminary Remediation Goals from the RI/FS and ROD

Reference Limits and Evaluation Table

Matrix:		Groundwater			
Analytical Group:		TAL Metals			
Concentration Level:		Low			
Analyte	CAS Number	Project Action Limit ¹ (µg/l)	Project Quantitation Limit (µg/l)	Achievable Laboratory Limits (µg/l)	
				MDL	RL
Antimony – Dissolved	7440-39-0	6	6	1.8	6
Arsenic – Dissolved	7440-38-2	10	10	3.2	10
Cadmium – Dissolved	7440-43-9	5	2	.66	2
Iron – Dissolved	7439-89-6	11000	100	81	100
Lead – Dissolved	7439-92-1	15	3	1.9	3
Manganese – Dissolved	7439-96-5	880	15	0.41	15

MDL = Minimum detection limit

RL = Reporting limit

1 = Based on the MCLs, SMCLs, and Risk-Based Preliminary Remediation Goals from the RI/FS and ROD

Reference Limits and Evaluation Table

Matrix: Groundwater					
Analytical Group: PCBs					
Concentration Level: Low					
Analyte	CAS Number	Project Action Limit ¹ (µg/l)	Project Quantitation Limit (µg/l)	Achievable Laboratory Limits (µg/l)	
				MDL	RL
Aroclor-1016	12674-11-2	0.5	0.5	0.17	0.5
Aroclor-1221	11104-28-2	0.5	0.5	0.13	0.5
Aroclor-1232	11141-16-5	0.5	0.5	0.16	0.5
Aroclor-1242	53469-21-9	0.5	0.5	0.22	0.5
Aroclor-1248	12672-29-6	0.5	0.5	0.1	0.5
Aroclor-1254	11097-69-1	0.5	0.5	0.16	0.5
Aroclor-1260	11096-82-5	0.5	0.5	0.17	0.5

MDL = Minimum detection limit

RL = Reporting limit

1 = Based on the MCLs, SMCLs, and Risk-Based Preliminary Remediation Goals from the RI/FS and ROD

Project Schedule/Timeline Table

Activities	Organization	Anticipated Date(s) of Initiation	Anticipated Date of Completion	Deliverable	Deliverable Due Date
Liquid Level Monitoring	Brown and Caldwell	To be determined	To be determined	Summary table Remedial Design Report	As per the CD and SOW
Soil and Groundwater Sampling	Brown and Caldwell	To be determined	To be determined	To be determined	Defined in the RDWP

Sampling Design and Rationale

The objectives of the pre-design activities include the following:

1. To further define the limits of the soil removal area, if needed;
2. To obtain groundwater quality data from more areas of the site as defined in the SOW.

Sampling Locations and Methods/SOP Requirements Table

Sampling Location/ID Number	Matrix	Depth (feet)	Analytical Group	Concentration Level	Frequency	Sampling SOP Reference	Rationale for Sampling Location
MW-A through MW-F	GW	TBD	VOC, SVOC, Metals	Low	Per Well	SOP #2 (FSP)	Well placement per SOW
MW-6R	GW	TBD	VOC, SVOC, Metals	Low	Depth Series	FSP and SOP #2	Well Placement per SOW
Soil Removal Area	Soil	TBD	VOC	Low	TBD	see FSP	Perimeter of soil removal area

TBD – To be determined based on specific boring/well, SOW requirements, and field judgment.

Analytical SOP Requirements Table

Matrix	Analytical Group	Analytical and Preparation Method / SOP Reference⁽¹⁾	Container (number, size, and type)	Sample Volume (units)	Preservation Requirements (chemical, temperature, light protected)	Maximum Holding Time (preparation / analysis)
Groundwater	TCL VOCs	SW-846 5030B, 8260B / NC-MS-019	(3) 40 mL vials		pH <2 with HCl, Cool to 4°C	14 days
Groundwater	TCL SVOCs	SW-846 5030B, 8270C / NC-MS-018 / NC-OP-32	(2) 1 liter ambers		Cool to 4°C	7 days extract/ 40 days analysis
Groundwater	PCBs	SW-846 8082 / NC-GC-038	(2) 1 liter ambers		Cool to 4°C	7 days extract/ 40 days analysis
Groundwater	TAL Metals	SW-846 3010A, 6010B/7470A / NC-MT-012 / NC-MT-013 / NCIP011	1 liter plastic	500 mLs	Cool to 4°C, pH <2 with HNO ₃	180 days; 28 days for Hg
Soil	TCL VOCs	SW-846 5030B, 8260B / NC-MS-019	Encores / Terracores / jars		Cool to 4°C	14 days
Soil	TCL SVOCs	SW-846 5030B, 8270C / NC-MS-018 / NC-OP-32	4 oz jar		Cool to 4°C	14 days to extract/ 40 days analysis
Soil	PCBs	SW-846 8082 / NC-GC-038	4 oz jar		Cool to 4°C	14 days to extract/ 40 days analysis
Soil	TAL Metals	SW-846 3010A, 6010B/7470A / NC-MT-011 / NC-MT-013 / NCIP010	4 oz jar		Cool to 4°C	180 days; 28 days for Hg

Field Quality Control Sample Summary Table

Matrix	Analytical Group	Analytical and Preparation Method / SOP Reference⁽¹⁾	Container (number, size, and type)	Sample Volume (units)	Preservation Requirements (chemical, temperature, light protected)	Maximum Holding Time (preparation / analysis)	Matrix
Groundwater	TCL VOCs	SW-846 5030B, 8260B / NC-MS-019	(3) 40 mL vials		pH <2 with HCl, Cool to 4°C	14 days	Groundwater
Groundwater	TCL SVOCs	SW-846 5030B, 8270C / NC-MS-018 / NC-OP-32	(2) 1 liter ambers		Cool to 4°C	7 days extract/ 40 days analysis	Groundwater
Groundwater	PCBs	SW-846 8082 / NC-GC-038	(2) 1 liter ambers		Cool to 4°C	7 days extract/ 40 days analysis	Groundwater
Groundwater	TAL Metals	SW-846 3010A, 6010B/7470A / NC-MT-012 / NC-MT-013 / NCIP011	1 liter plastic	500 mLs	Cool to 4°C, pH <2 with HNO ₃	180 days; 28 days for Hg	Groundwater
Soil	TCL VOCs	SW-846 5030B, 8260B / NC-MS-019	Encores / Terracores / jars		Cool to 4°C	14 days	Soil
Soil	TCL SVOCs	SW-846 5030B, 8270C / NC-MS-018 / NC-OP-32	4 oz jar		Cool to 4°C	14 days to extract/ 40 days analysis	Soil
Soil	PCBs	SW-846 8082 / NC-GC-038	4 oz jar		Cool to 4°C	14 days to extract/ 40 days analysis	Soil
Soil	TAL Metals	SW-846 3010A, 6010B/7470A / NC-MT-011 / NC-MT-013 / NCIP010	4 oz jar		Cool to 4°C	180 days; 28 days for Hg	Soil

Field Quality Control Sample Summary Table

Matrix	Analytical Group	Concentration Level	Analytical and Preparation SOP Reference	No. of Sampling Locations	No. of Field Duplicate Pairs (1)	No. of MS (1)	No. of Field Blanks (1)	No. of Equip. Blanks (1)	No. of Trip Blank Samples (1)	Total No. of Samples to Lab
Aqueous and non-aqueous environmental samples	VOCs, SVOCS, PCBs	Inclusive	TestAmerica SOP Nos. NCMS018, NCOP32, NCMS019, NCGC038	TBD	5% of environmental samples per matrix	5% of environmental samples per matrix	5% of environmental samples per matrix	5% of environmental samples per matrix	One per shipment with VOC samples	TBD
Aqueous and non-aqueous environmental samples	Metals	Inclusive	TestAmerica SOP Nos. NCMT012, NCMT013, NCMT011, NCIP011, NCIP010	TBD	5% of environmental samples per matrix	5% of environmental samples per matrix	5% of environmental samples per matrix	5% of environmental samples per matrix	5% of environmental samples per matrix	TBD
Solid	TCLP extraction	Inclusive	TestAmerica SOP No. NCOP033	TBD	NA	NA	NA	NA	NA	TBD

1. – Minimum of one sample per matrix per sample delivery group

TBD – To be determined

NA – Not applicable

Project Sampling SOP References Table

Reference Number	Title, Revision Date and/or Number	Originating Organization	Equipment Type	Modified for Project Work? (Y/N)	Comments

Field Equipment Calibration, Maintenance, Testing, and Inspection Table

Field Equipment	Calibration Activity	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference
Photo-ionization Detector	Internal and against known standard	As per Owner's Manual	As per Owner's Manual	As per Owner's Manual	Daily	As per Owner's Manual	As per Owner's Manual	Field Team	Owner's Manual
Multi-Gas Meter	Internal and against known standard	As per Owner's Manual	As per Owner's Manual	As per Owner's Manual	Daily	As per Owner's Manual	As per Owner's Manual	Field Team	Owner's Manual
Multi-Parameter Groundwater Field Instrument	Against known standard	As per Owner's Manual	As per Owner's Manual	As per Owner's Manual	Daily	As per Owner's Manual	As per Owner's Manual	Field Team	Owner's Manual
Water Level Meter	None	As per Owner's Manual	As per Owner's Manual	As per Owner's Manual	NA	As per Owner's Manual	As per Owner's Manual	Field Team	Owner's Manual
Interface Probe	None	As per Owner's Manual	As per Owner's Manual	As per Owner's Manual	NA	As per Owner's Manual	As per Owner's Manual	Field Team	Owner's Manual

NA = Not applicable

Analytical SOP References Table

Lab SOP Number	Title, Revision Date, and / or Number	Definitive or Screening Data	Matrix and Analytical Group	Instrument	Organization Performing Analysis	Modified for Project Work? ¹ (Y/N)
NC-MS-018	Revision 1, 12/16/2008 GC/MS Analysis based on Method 8270C	Definitive	Semi-Volatiles	GC/MS	TestAmerica	N
NC-OP-32	Revision 1.0, 01/07/2009 Extraction of Organic Compounds from Waters and Soils , based on SW846 3500 Series and 600 Series Methods	NA	Organic Prep	NA	TestAmerica	N
NC-OP-033	Revision 0, 03/31/2008 Toxicity Characteristic Leaching Procedure and Synthetic Precipitation Leaching Procedure	NA	TCLP extraction	NA	TestAmerica	N
NC-MS-019	Revision 10, 01/07/2009 Determination of Volatile Organics by GC/MS based on Methods 8260B and 8260A.	Definitive	Volatiles	GC/MS	TestAmerica	N
NC-MT-012	Revision 1, 01/07/2009 Inductively Coupled Plasma – Atomic Emission Spectroscopy, Spectrometric Method for Trace Element Analysis	Definitive	Metals	ICP	TestAmerica	N
NC-GC-038	Revision 1, 01/15/2009 Gas Chromatographic Analysis Based on Methods 8000B, 8021B, 8081A, 8082, 8151A, 615 and 8015B.	Definitive	Pests, Herbs, PCBs	GC	TestAmerica	N

Analytical SOP References Table

Lab SOP Number	Title, Revision Date, and / or Number	Definitive or Screening Data	Matrix and Analytical Group	Instrument	Organization Performing Analysis	Modified for Project Work?1 (Y/N)
NC-MT-013	Revision 0, 01/07/2009 Preparation and Analysis of Mercury in Aqueous Samples by Cold Vapor Atomic Absorption, SW846 7470A and MCAWW 245.1	Definitive	Mercury	CVAA	TestAmerica	N
NCMT011	Rev 1, 01/07/2009 Preparation and Analysis of Mercury in Solid Samples by Cold Vapor Atomic Absorption Spectroscopy	Definitive	Mercury	CVAA	TestAmerica	No
NCIP011	Rev 0, 01/07/2009 Acid Digestion for Aqueous Samples	Definitive	Metals Prep	NA	TestAmerica	No
NCIP010	Rev 1, 01/07/2009 Acid Digestion for Soil Samples	Definitive	Metals Prep	NA	TestAmerica	No

NA – Not applicable

Analytical Instrument Calibration Table

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for CA	SOP Reference
GC/MS	Check of mass spectral ion intensities (tuning procedure) using BFB (8260B) and DFTPP (8270C)	Prior to initial calibration and calibration verification (every 12 hours)	Must meet the method requirements before samples are analyzed.	Retune instrument and verify the tune acceptability	QA Manager/Group Leader/Analyst	NC-MS-018, NC-MS-019
	Minimum five-point initial calibration for target analytes, lowest concentration standard at or near the reporting limit	Initial calibration prior to sample analysis	<u>8260B</u> : The minimum average SPCC RF for Chloromethane, 1,1-Dichloroethane, Bromoform is 0.1; for Chlorobenzene and 1,1,2,2-Tetrachloroethane is 0.3 <u>8270C</u> : The minimum average SPCC RF is 0.050. <u>8260B and 8270C</u> : RSD is less than or equal to 15% or $R^2 > 0.99$ for target analytes, and is less than or equal to 30% for CCC	Correct problem, then repeat initial calibration	QA Manager/Group Leader/Analyst ^b	NC-MS-018, NC-MS-019
	Second-source calibration verification	Once per five-point initial calibration	Less than 20% for CCC compounds, less than or equal to 50% for non-CCC compounds. Allowance for 6 compounds above 50%	Correct problem, then repeat second source verification. If it still fails, then repeat initial calibration	QA Manager/Group Leader/Analyst ^b	NC-MS-018, NC-MS-019

Analytical Instrument Calibration Table

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for CA	SOP Reference
GC/MS	Daily calibration verification	Before sample analysis and at beginning of every 12 hours of analysis time	<u>8260B</u> : The minimum average SPCC RF for Chloromethane, 1,1-Dichloroethane, Bromoform is 0.1; for Chlorobenzene and 1,1,2,2-Tetrachloroethane is 0.3 <u>8270C</u> : The minimum average SPCC RF is 0.050. <u>8260B and 8270C</u> ^a : The percent drift/difference for RF is less than or equal to 20% for CCC analytes and Gasoline.	Correct problem, then repeat CCV. If still fails, repeat initial calibration	QA Manager/Group Leader/Analyst ^b	NC-MS-018, NC-MS-019
Metals (ICP)	Internal standards	During acquisition of calibration standard	Areas within -50% to +100% of last ICAL mid-point for each CCV	Inspect mass spectrometer and GC for malfunctions; mandatory reanalysis of samples analyzed while system was malfunctioning	Lab Manager / Analyst ^b	NC-MS-018, NC-MS-019
Metals (ICP)	Initial calibration per manufacturer's instructions, with a minimum of one standard and a calibration blank	Initial calibration prior to sample analysis	Accepted if the initial calibration verification (ICV) passes	Correct problem, then repeat initial calibration .	Group Leader / Analyst	NC-MT-012

Analytical Instrument Calibration Table

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for CA	SOP Reference
	Low concentration standard at or near the reporting limit	After one point calibration	Advisory limits of +/-50	Evaluate run based on advisory limits.	Group Leader / Analyst	NC-MT-012
	Second-source (ICV) calibration verification	Once per initial calibration	Within 10%	Correct problem, then repeat. If still fails, repeat initial calibration	Group Leader / Analyst	NC-MT-012
Metals ICPMS	Continuing calibration verification (CCV)	After every 10 samples and the end of the sequence	Within 10%	Correct problem, then repeat. If still fails, repeat initial calibration. If CCV is biased high and associated samples are below the RL the data can be reported	Group Leader / Analyst	NC-MT-012
Metals ICPMS	Initial calibration per manufacturer's instructions, with a minimum of one standard and a calibration blank	Initial calibration prior to sample analysis	Correlation coefficient >0.995 (if more than one point); accepted if the initial calibration verification (ICV) passes	Correct problem, then repeat initial calibration	Group Leader / Analyst	NC-MT-002
	Second-source (ICV) calibration verification	Once per initial calibration	Within 10%	Correct problem, then repeat. If still fails, repeat initial calibration	Group Leader / Analyst	NC-MT-002
	Continuing calibration verification (CCV)	After every 10 samples and the end of the sequence	Within 10%	Correct problem, then repeat. If still fails, repeat initial calibration. If CCV is biased high and associated samples are below the RL the data can be reported.	Group Leader / Analyst	NC-MT-012

Analytical Instrument Calibration Table

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for CA	SOP Reference
Metals (CVAA)	Initial calibration (IC) per manufacturer's instructions, with a minimum of five standards and a calibration blank	Initial calibration prior to sample analysis	Correlation coefficient >0.995; accepted if the initial calibration verification (ICV) passes	Correct problem, then repeat initial calibration	Group Leader / Analyst	NC-MT-011 NC-MT-013
	Second-source ICV, prepared at the calibration midpoint	Once per initial calibration	Within 10%	Correct problem, then repeat. If still fails, repeat initial calibration	Group Leader / Analyst	NC-MT-011 NC-MT-013
PCBs (GC)	Minimum five-point initial calibration for target analytes, lowest concentration standard at or near the reporting limit	Initial calibration prior to sample analysis	A minimum of 5 points for % RSD. Must pass <20%. Quadratic requires 6 points passing by a minimum Coefficient of 0.990 Linear must pass by a coefficient of 0.990	Correct problem, then repeat initial calibration	QA Manager/Group Leader/Analyst ^b	NC-GC-038
PCBs (GC)	Second-source calibration verification	Once per five-point initial calibration	ICV Must pass <15% for TCL compounds. Non TCL compounds must pass by .30%	Correct problem, then repeat second source verification. If it still fails, then repeat initial calibration	QA Manager/Group Leader/Analyst ^b	NC-GC-038

Analytical Instrument and Equipment Maintenance, Testing, and Inspection Table

Instrument / Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person²	SOP Reference
GC	Change septum, clean injection port, change or clip column, install new liner	Detector signals and chromatogram review	Instrument performance and sensitivity	As needed	CCV passes criteria	Reinspect injector port, cut additional column, reanalyze CCV, recalibrate instrument	Test America Chemist	NC-GC-038
GC-MS	Clean sources, maintain vacuum pumps	Tuning	Instrument performance and sensitivity	Service vacuum pumps twice per year, other maintenance as needed	Tune and CCV pass criteria	Recalibrate instrument	Test America Chemist	NC-MS-018, NC-MS-019
GC-MS	Change septum, clean injection port, change or clip column, install new liner, change trap	Response factors and chromatogram review	Instrument performance and sensitivity	As needed	Tune and CCV pass criteria	Reinspect injector port, cut additional column, reanalyze CCV, recalibrate instrument	Test America Chemist	NC-MS-018, NC-MS-019
ICP	Replace disposables, flush lines, clean injector and torch	Intensity of 1PPM Manganese STD within criteria	Check connections	Daily or as needed	Intensity of 1PPM Manganese STD within criteria	Replace, investigate injector, reanalyze	Test America Chemist	NC-MT-002
ICP	Replace pump windings	Monitor ISTD counts for variation	Instrument performance and sensitivity	As needed	Monitor ISTD counts for variation	Replace windings, recalibrate and reanalyze	Test America Chemist	NC-MT-002
CVAA	Replace disposables, flush lines	Sensitivity check	Instrument performance and sensitivity	Daily or as needed	CCV pass criteria	Recalibrate	Test America Chemist	NC-MT-013
ICPMS	Change tubing	Monitor Indium intensity counts	Instrument performance and	As needed	Pass performance report	Replace tubing, perform	Test America Chemist	NC-MT-002

Analytical Instrument and Equipment Maintenance, Testing, and Inspection Table

Instrument / Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person²	SOP Reference
			sensitivity			performance report		
ICPMS	Clean cones	Monitor Indium intensity counts	Instrument performance and sensitivity	As needed	Pass performance report	Clean, replace perform performance report	Test America Chemist	NC-MT-002

Sample Handling System

SAMPLE COLLECTION, PACKAGING, AND SHIPMENT
Sample Collection (Personnel/Organization): Lead Field Geologist/BC Support Field Staff, Brown and Caldwell
Sample Packaging (Personnel/Organization): Lead Field Geologist/BC Support Field Staff, Brown and Caldwell
Coordination of Shipment (Personnel/Organization): Lead Field Geologist/BC Support Field Staff, Brown and Caldwell
Type of Shipment/Carrier: Hand delivery, laboratory courier and/or FedEx
SAMPLE RECEIPT AND ANALYSIS
Sample Receipt (Personnel/Organization): Receiving counter of analytical laboratories as per QA Manual (Attachment A)
Sample Custody and Storage (Personnel/Organization): Analytical laboratories as per QA Manual (Attachment A)
Sample Preparation (Personnel/Organization): Analytical laboratories as per QA Manual (Attachment A) and test method SOP/ASTM standard
Sample Determinative Analysis (Personnel/Organization): Analytical laboratories as per QA Manual (Attachment A) and test method SOP/ASTM std.
SAMPLE ARCHIVING
Field Sample Storage (No. of days from sample collection): Analytical laboratories as per QA Manual (Attachment A) and method SOP
Sample Extract/Digest Storage (No. of days from extraction/digestion): Analytical laboratory as per QA Manual (Attachment A) and method SOP
Biological Sample Storage (No. of days from sample collection): Analytical laboratory as per QA Manual (Attachment A) and method SOP
SAMPLE DISPOSAL
Personnel/Organization: Analytical laboratories as per QA Manual (Attachment A) and method SOP
Number of Days from Analysis: Analytical laboratories as per QA Manual (Attachment A) and method SOP

Sample Custody Requirements

Field Sample Custody Procedures (sample collection, packaging, shipment, and delivery to laboratory):

Each environmental sample will be properly identified and individually labeled. Labels will be filled out in indelible ink with at least the following information: BC sample identification, date and time of sample collection, initials of sampler(s), analysis/test required, and preservation (as appropriate). The sample label will be securely attached to the sample container.

Environmental samples being analyzed by the analytical laboratory will be properly packaged and shipped for analysis. Following labeling, the sample bottles will be sealed with custody seals, and enclosed in clear sealable plastic bags (e.g., Ziploc® bags), through which the identifying label is visible.

The sample containers, sealed in bags, will then be placed in a hard plastic cooler, an effort will be made to fill in voids with either ice or packaging material (e.g. bubble wrap). Samples are to be packed with sufficient ice (enclosed in double-bagged sealable plastic bags) to cool the samples to $4\pm 2^{\circ}\text{C}$. Additionally, each iced cooler will be packed with a cooler temperature blank. Lastly, the cooler will be filled with adequate cushioning material to minimize the possibility of container breakage.

Laboratory Sample Custody Procedures (receipt of samples, archiving, disposal):

Laboratory custody procedures are described in the attached analytical laboratory QA Manual in Attachments A.

Sample Identification Procedures:

The method of identification of a sample depends on the type of measurement or analysis performed. When field screening measurements (e.g., pH, dissolved oxygen, or turbidity) are made, data will be recorded directly in logbooks or on field investigation forms. Identifying information such as project name, station number, station location, date and time, name of sampler, field observations, remarks, or other pertinent information will be recorded.

Samples collected for laboratory analysis during the field investigation will be specifically designated by BC personnel for unique identification. Each sample will be designated by an alpha-numeric code which will identify the sampling location, type or as necessary depth.

Sample Custody Requirements

The three codes that make up the sample identifier are described as follows:

1. The Site name – CRS (Chemical Recovery Systems, Inc. Site);
2. The medium/sample type codes are listed below:

MW - Groundwater sample taken from a monitoring well;

SW – Surface water sample;

SP – Seep sample;

SED – Sediment sample;

S – Soil sample;

DW – Drummed waste sample;

W – Waste sample;

SB – Soil boring sample;

TB – Trip Blank;

FB – Field Blank sample;

MS/MSD – Matrix spike/matrix spike duplicate sample;

DUP – Duplicate sample; and

3. The location code will be keyed to the specific sample designation.

The following is an example of a sample identifier that will be used for samples collected for laboratory analysis: **CRS-SB-10A-2-4**; indicating that the soil sample was collected from the first boring at soil boring location at CRS-SB-10 from a depth of 2 to 4 feet below ground surface.

Sample Custody Requirements

Chain-of-custody Procedures:

A completed COC form must be included with all sample transfers/shipments.

When analytical samples are being shipped by an overnight delivery service to the laboratory, the COC form and any other paperwork will be checked against the sample labels and field documentation, and then placed in a waterproof sealable plastic bag and taped securely to the inside lid of the cooler. The cooler must then be secured, with custody seals affixed over the lid opening in at least two locations, and the cooler wrapped with strapping tape (without obscuring the custody seals). Orientation “this end up” arrows will be drawn or attached on two sides of the cooler, and a completed overnight delivery service shipping label will be attached to the top or handle of the cooler. Wide, clear tape should be used to secure the label to the lid of the cooler to prevent the shipping address label from being accidentally peeled off the cooler top.

Samples to be shipped by an overnight delivery service will be shipped within 24 hours of sample collection and arrive at the laboratory within 24 hours of sample shipment. A member of the field team will contact the laboratory directly, to notify them of a sample shipment, and again the next day to confirm receipt. In addition, an electronic version of the COCs will be sent to the laboratory either electronically or by facsimile.

If the laboratory is going to courier the samples directly from the site or the samples are being delivered directly to the laboratory by BC, the COC form will not be placed inside the cooler. The COC form must be signed by the receiver (e.g., the laboratory courier, or the laboratory sample custodian) when he/she accepts possession of the samples.

QC Samples Table

Matrix	Water/Soil
Analytical Group	GC semi-volatiles
Analytical Method / SOP Reference	EPA 8082

QC Sample	Frequency/ Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Method Blank	1/Batch (20 samples)	No Target Compounds>RL; no common lab contaminants >RL.	If sufficient sample is available, reanalyze samples. Qualify data as needed. Report results if sample results >20x blank result or sample results ND.	Analyst / Section Supervisor	Accuracy/Bias-Contamination	No Target Compounds>RL; no common lab contaminants >RL.
Instrument Blank	Not required for PCB analysis	.				
Laboratory Control Sample	LCS if prepping an MS/MSD LCS/LCSD if no MS/MSD	Refer to Attachment B for LCS control limits.	If sufficient sample is available, reanalyze samples. Qualify data as needed.	Analyst / Section Supervisor	Accuracy/Bias	Laboratory % Recovery Control Limits
Matrix Spike/Matrix Spike Duplicate	1/Batch (20 samples)	Refer to Attachment B for MS control limits.	Determine root cause; flag MS/MSD data; discuss in narrative.	Analyst / Section Supervisor	Accuracy/Bias/Precision	Laboratory % Recovery / RPD Control Limits
Surrogates	Every sample	Refer to Attachment B for surrogate control limits.	Check calculations and instrument performance; recalculate, reanalyze.	Analyst / Section Supervisor	Accuracy/Bias	Laboratory % Recovery Control Limits

QC Samples Table

Matrix	Water/Soil
Analytical Group	GC Semi
Analytical Method / SOP Reference	8081/8151

QC Sample	Frequency/ Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Method Blank	1/Batch (20 samples)	No Target Compounds>RL; no common lab contaminants >RL.	If sufficient sample is available, reanalyze samples. Qualify data as needed. Report results if sample results >20x blank result or sample results ND.	Analyst / Section Supervisor	Accuracy/Bias-Contamination	No Target Compounds>RL; no common lab contaminants >RL.
Laboratory Control Sample	1/Batch (20 samples) LCSD required if no MS/MSD	Refer to Attachment B for LCS control limits.	If sufficient sample is available, reanalyze samples. Qualify data as needed.	Analyst / Section Supervisor	Accuracy/Bias	Laboratory % Recovery Control Limits
Matrix Spike/Matrix Spike Duplicate	1/Batch (20 samples)	Refer to Attachment B for MS control limits.	Determine root cause; flag MS/MSD data; discuss in narrative.	Analyst / Section Supervisor	Accuracy/Bias/Precision	Laboratory % Recovery / RPD Control Limits
Surrogates	Every sample	Refer to Attachment B for surrogate control limits.	Check calculations and instrument performance; recalculate, reanalyze.	Analyst / Section Supervisor	Accuracy/Bias	Laboratory % Recovery Control Limits

QC Samples Table

Matrix	Water/Soil					
Analytical Group	ICP Metals					
Analytical Method / SOP Reference	EPA 6010 / NC-MT-012					
QC Sample	Frequency/ Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Calibration blank (CCB)	After CCV, after every 10 samples, and at the end of the sequence	No target analytes > RL If CCB is biased high and associated samples are below the RL the data can be reported. .	Correct the problem and reanalyze the blank and previous samples associated with CCB	Group Leader / Analyst	Accuracy	No target analytes > 2x MDL
MDL study	After initial setup and once per 12-months; otherwise quarterly MDL verification checks shall be performed.	MDLs will be below the RLs	.	Group Leader / Analyst	Sensitivity	MDLs will be below the RLs
Method blank	One per digestion batch	No target analytes > RL For common laboratory contaminants, no analytes >2x RL.. If MB is biased high and associated samples are below the RL or 20X the blank the data is accepted.	Re-analyze. Correct problem, then re-prepare and reanalyze the method blank and all samples processed with the contaminated blank	Group Leader / Analyst	Accuracy/Bias Contamination	No target analytes > ½ RL
Interference check solution (ICS)	At the beginning of an analytical run	ICSA: For non-interfering elements with RL's less than 10 , must fall within 2x the RL from zero. For RL's >10 must fall within 1x RL from zero. If not evaluate run based on lab SOP	Terminate analysis, correct problem, then reanalyze ICS and all affected samples	Group Leader / Analyst	Accuracy	Within ±20% of expected value

QC Samples Table

Matrix		Water/Soil				
		ICSAB Within $\pm 20\%$ of expected value. expected value.				
MS	One MS per preparation batch	QC acceptance criteria: 80% to 120% accuracy, 20% precision; or laboratory statistically derived control limits	Flag data with N	Group Leader / Analyst	Accuracy	QC acceptance criteria: 80% to 120% accuracy, 20% precision or laboratory statistically derived control limits
MSD or sample duplicate	One per preparation batch	RPD < or equal to 20%	Flag data with N	Group Leader / Analyst	Precision	RPD < or equal to 20%
LCS	One LCS per each preparation batch	Laboratory statistically derived control limits : 80% to 120% accuracy. Or in house limits If the LCS is biased high and the associated samples are ND the data can be reported.,	Terminate analysis, identify and correct the problem, then re-prepare and reanalyze all affected samples and QC	Group Leader / Analyst	Accuracy	QC acceptance criteria: 80% to 120% accuracy, 20% precision or laboratory statistically derived control limits
Dilution test	Each preparation batch or when a new sample matrix is encountered.	1:5 dilution must agree within $\pm 10\%$ of the original determination	Flag data with an E	Group Leader / Analyst	Accuracy	10% Difference

QC Samples Table

Matrix	Water / Soil
Analytical Group	Semi Volatile Organics
Analytical Method / SOP Reference	EPA 8270C/ NC-MS-018,

QC Sample	Frequency/ Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Method Blank	1/Batch (20 samples)	No Target Compounds>RL; no common lab contaminants >RL.	If sufficient sample is available, reanalyze samples. Qualify data as needed. Report results if sample results >20x blank result or sample results ND.	Analyst / Section Supervisor	Accuracy/Bias-Contamination	No Target Compounds>RL; no common lab contaminants >RL.
Laboratory Control Sample	1/Batch(20samples)_LCSD if no MS/MSD	Refer to Attachment B for LCS control limits.	If sufficient sample is available, reanalyze samples. Qualify data as needed.	Analyst / Section Supervisor	Accuracy/Bias	Laboratory % Recovery Control Limits
Matrix Spike/Matrix Spike Duplicate	1/Batch (20 samples)	Refer to Attachment B for MS control limits.	Determine root cause; flag MS/MSD data; discuss in narrative.	Analyst / Section Supervisor	Accuracy/Bias/Precision	Laboratory % Recovery / RPD Control Limits
Surrogates	Every sample	Refer to Attachment B for surrogate control limits.	Check calculations and instrument performance; recalculate, reanalyze.	Analyst / Section Supervisor	Accuracy/Bias	Laboratory % Recovery Control Limits

QC Samples Table

Matrix	Water/Soil					
Analytical Group	Volatile Organics					
Analytical Method / SOP Reference	EPA 8260B/ NC-MS-019, Rev 10					
QC Sample	Frequency/ Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Method Blank	1/Batch (20 samples)	No Target Compounds>RL; no common lab contaminants >5XRL.	If sufficient sample is available, reanalyze samples. Qualify data as needed. Report results if sample results >20x blank result or sample results ND.	Analyst / Section Supervisor	Accuracy/Bias-Contamination	No Target Compounds>RL; no common lab contaminants >RL.
Instrument Blank	Once per 12 hours if method blank is not run	No Target Compounds>RL; no common lab contaminants >5XRL.	If sufficient sample is available, reanalyze samples. Qualify data as needed. Report results if sample results >20x blank result or sample results ND.	Analyst / Section Supervisor	Accuracy/Bias-Contamination	No Target Compounds>1/2RL; no common lab contaminants >RL.
Laboratory Control Sample	1/Batch (20 samples)	Refer to Attachment B for LCS control limits.	If sufficient sample is available, reanalyze samples. Qualify data as needed.	Analyst / Section Supervisor	Accuracy/Bias	Laboratory % Recovery Control Limits
Matrix Spike/Matrix Spike Duplicate	1/Batch (20 samples)	Refer to Attachment B for MS control limits.	Determine root cause; flag MS/MSD data; discuss in narrative.	Analyst / Section Supervisor	Accuracy/Bias/Precision	Laboratory % Recovery / RPD Control Limits
Surrogates	Every sample	Refer to Attachment B for surrogate control limits.	Check calculations and instrument performance; recalculate, reanalyze.	Analyst / Section Supervisor	Accuracy/Bias	Laboratory % Recovery Control Limits

Project Documents and Records Table

Sample Collection Documents and Records	On-site Analysis Documents and Records	Off-site Analysis Documents and Records	Data Assessment Documents and Records	Other
<ul style="list-style-type: none">• Field logbooks• COC forms• Field sample forms	<ul style="list-style-type: none">• COC forms• Logbooks (instrument calibration, trouble-shooting, sample log-in)• Field sample forms	<ul style="list-style-type: none">• Sample receipt logs• Internal and external COC forms• Equipment maintenance logs• Corrective action documentation	<ul style="list-style-type: none">• Field inspection checklist(s)• Data review documentation• Review forms for electronic entry of data into database• Corrective action documentation	<ul style="list-style-type: none">• Preliminary Design Report• Final Design Report

Analytical Services Table

Matrix	Analytical Group	Sample Locations/ID Number	Analytical Method	Data Package Turnaround Time	Laboratory / Organization (name and address, contact person and telephone number)	Backup Laboratory / Organization (name and address, contact person and telephone number)
Water / Soil	VOCs	CRS Site	8260B	14 Calendar days	TestAmerica North Canton, 4101 Shuffel Street, NW, North Canton, Ohio 44720 Contact: Alesia Danford Phone: (330) 497-0772	NA
Water / Soil	Metals	CRS Site	6010B / 6020 / 7470 / 7471	14 Calendar days	TestAmerica North Canton, 4101 Shuffel Street, NW, North Canton, Ohio 44720 Contact: Alesia Danford Phone: (330) 497-0772	NA
Water / Soil	PCBs	CRS Site	PCB	14 Calendar Days	TestAmerica North Canton, 4101 Shuffel Street, NW, North Canton, Ohio 44720 Contact: Alesia Danford Phone: (330) 497-0772	NA
Water / Soil	SVOCs	CRS Site	8270C	14 Calendar Days	TestAmerica North Canton, 4101 Shuffel Street, NW, North Canton, Ohio 44720 Contact: Alesia Danford Phone: (330) 497-0772	NA

NA – Not applicable

Planned Project Assessments Table

Assessment Type	Frequency	Internal or External	Organization Performing Assessment	Person(s) Responsible for Performing Assessment (Title and Organizational Affiliation)	Person(s) Responsible for Responding to Assessment Findings (Title and Organizational Affiliation)	Person(s) Responsible for Identifying and Implementing Corrective Actions (CA) (Title and Organizational Affiliation)	Person(s) Responsible for Monitoring Effectiveness of CA (Title and Organizational Affiliation)
Data review	Upon Receipt of all data	Internal	TestAmerica	Dorothy Leeson, QA Manager for TestAmerica	Senior Chemist for affected laboratory procedure - TestAmerica	Opal Davis-Johnson, Laboratory Manager, TestAmerica	Dorothy Leeson, QA Manager, TestAmerica
Data review	Upon Receipt of Data	External	BC	James Krebs, P.E., QA Officer, BC	James Peebles, P.E., Project Manager, BC	James Krebs, P.E, QA Officer, BC	James Krebs, P.E., QA Officer, BC

Assessment Findings and Corrective Action Responses

Assessment Type	Nature of Deficiencies Documentation	Individual(s) Notified of Findings (Name, Title, Organization)	Timeframe of Notification	Nature of Corrective Action Response Documentation	Individual(s) Receiving Corrective Action Response (Name, Title, Org.)	Timeframe for Response
Review field records	Sample collection methods will yield unusable result	Patrick Steerman (SEMC), CRS Settling Performing Parties, Michelle Kerr (USEPA RPM)	14 days after finding	In writing via e-mail	Patrick Steerman (SEMC), CRS Settling Performing Parties, Michelle Kerr (USEPA RPM)	As indicated in CA response
Review field records	Scheduled sample not collected	Patrick Steerman (SEMC), CRS Settling Performing Parties, Michelle Kerr (USEPA RPM)	14 days after finding	In writing via e-mail	Patrick Steerman (SEMC), CRS Settling Performing Parties, Michelle Kerr (USEPA RPM)	As indicated in CA response
Qualitative laboratory data review	Inappropriate analytical/testing methods yield unusable result	Patrick Steerman (SEMC), CRS Settling Performing Parties, Michelle Kerr (USEPA RPM)	14 days after finding	In writing via e-mail	Patrick Steerman (SEMC), CRS Settling Performing Parties, Michelle Kerr (USEPA RPM)	As indicated in CA response

QA Management Reports Table

Type of Report	Frequency (daily, weekly monthly, quarterly, annually, etc.)	Projected Delivery Date(s)	Person(s) Responsible for Report Preparation (Title and Organizational Affiliation)	Report Recipient(s) (Title and Organizational Affiliation)
Preliminary Remedial Design	Draft and Final	As per the CD, SOW, and RD Work Plan	James Peeples P.E., Project Manager, BC	Michelle Kerr (USEPA) Lawrence Antonelli (OEPA) Patrick Steerman (SEMC) CRS Settling Performing Parties
Final Remedial Design	Draft and Final	As per the CD, SOW, and RD Work Plan	James Peeples P.E., Project Manager, BC	Michelle Kerr (USEPA) Lawrence Antonelli (OEPA) Patrick Steerman (SEMC) CRS Settling Performing Parties

Verification (Step I) Process Table

Verification Input	Description	Internal/ External	Responsible for Verification (Name, Organization)
Field logbook entries	Field notes will be reviewed for completeness.	I	James R. Krebs, BC
Chains-of-custody	COC forms will be reviewed for completeness.	I	James R. Krebs, BC
Laboratory analytical/testing data package	Data packages will be reviewed for completeness.	I	James R. Krebs, BC
Laboratory QA/QC data package	Data packages will be reviewed for completeness.	I	James R. Krebs, BC
Database	Database will be reviewed for completeness and technical accuracy.	I	James R. Krebs, BC

Sampling and Analysis Validation (Steps IIa and IIb) Process Table

Step IIa/IIb	Validation Input	Description	Responsible for Validation (Name, Organization)
Iia	SOPs	Verify that sampling methods/procedures were followed, and that deviations were noted/approved.	James R. Krebs, BC
Iib	SOPs	Determine potential impacts from noted/approved deviations, in regard to PQOs.	James R. Krebs, BC
Iia	Chains of custody	Examine COC forms against QAPP and laboratory contract requirements (e.g., analytical methods, sample identification, etc.).	James R. Krebs, BC
Iia	Laboratory data package	Examine packages against QAPP and laboratory contract requirements, and against COC forms (e.g., holding times, sample handling, analytical methods, sample identification, data qualifiers, QC samples, etc.).	James R. Krebs, BC
Iib	Laboratory data package	Determine potential impacts from noted/approved deviations, in regard to PQOs. Examples include PQLs and QC sample limits (precision/accuracy).	James R Krebs, BC
Iib	Field and lab duplicates	Compare results of field duplicate (or replicate) analyses with RPD criteria.	James R. Krebs, BC

Step IIa – Compliance with methods, procedures, and contracts

Step IIb – Compliance with QAPP quality objectives

Sampling and Analysis Validation (Steps IIa and IIb) Summary Table

Step IIa/IIb	Matrix	Analytical Group	Concentration Level	Validation Criteria	Data Validator (title and organizational affiliation)
IIa / IIb	Inclusive	Inclusive	Inclusive	Qualitative data review according to Worksheets No. 11, 12, 19, 28	James R. Krebs, BC

Step IIa – Compliance with methods, procedures, and contracts

Step IIb – Compliance with QAPP quality objectives

Evaluation Procedure:

- Liquid level measurement results will be reviewed to determine the presence/absence of LNAPL/DNAPL.
- Analytical results will be evaluated with respect to QA assessment and their ability to satisfy project objectives.

Personnel responsible for performing the usability assessment:

- James R. Krebs, P.E., Quality Assurance Officer, BC.

Usability Assessment Documentation:

- Laboratory summary reports
- Laboratory QA reports
- Brief narrative describing data review and data usability will be presented in the Remedial Design Report

ATTACHMENT A

Cover Page:

Quality Assurance Manual

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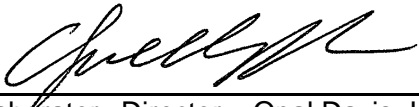
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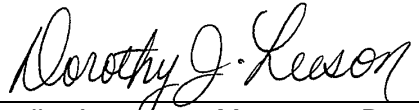
**Quality Assurance Manual
Approval Signatures**



Laboratory Director – Opal Davis-Johnson

07/21/10

Date



Quality Assurance Manager – Dorothy Leeson

07/21/10

Date



Technical Director – Dr. Mark Bruce

07/15/10

Date

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SOPs AND POLICIES REFERRED TO IN THE QA MANUAL

SOP/Policy Reference	Title
CA-C-S-001	Work Sharing Process
CA-L-P-001	Ethics Policy
CA-L-P-002	Contract Compliance Policy
CA-L-S-001	Internal Investigation of Potential Data Discrepancies and Determination for Data Recall
CA-L-S-002	Subcontracting Procedures
CA-Q-S-001	Solvent and Acid Lot Testing and Approval
CA-Q-S-002	Acceptable Manual Integration Practices
CA-Q-S-003	Management of Change Procedure
CA-Q-S-004	Method Compliance & Data Authenticity Audits
CA-Q-S-006	Detection Limits
CA-Q-S-008	Management Systems Review
CA-T-P-001	Qualified Products List
CW-E-M-001	Corporate Environmental Health & Safety Manual
CW-F-P-002	Authorization Matrix
CW-F-P-004	Procurement and Contracts Policy
CW-F-S-007	Controlled Purchases Policy
CW-F-S-018	Vendor Selection
CW-Q-S-001	Corporate Document Control and Archiving
CW-Q-S-002	Writing a Standard Operating Procedure (SOPs)
CA-Q-M-002	Corporate Quality Management Plan
NC-QA-015	Equipment Monitoring and Thermometer Calibration
NC-QA-018	Statistical Evaluation of Data and Development of Control Charts
NC-QA-019	Records Information Management
NC-QA-027	Preparation and Management of Standard Operating Procedures
NC-QA-028	Employee Orientation and Training
NC-QA-029	Nonconformance and Corrective Action System
NC-SC-005	Sample Receiving and Sample Control
NC-SC-006	Sample Procurement Protocol
CA-Q-T-005	Laboratory Documentation
NC-QA-021	Evaluation of Method Detection Limits for Chemical Tests

SECTION 3

INTRODUCTION (NELAC 5.1 - 5.3)

3.1 INTRODUCTION AND COMPLIANCE REFERENCES

TestAmerica North Canton's Quality Assurance Manual (QAM) is a document prepared to define the overall policies, organization objectives and functional responsibilities for achieving TestAmerica's data quality goals. The laboratory maintains a local perspective in its scope of services and client relations and maintains a national perspective in terms of quality.

The QAM has been prepared to assure compliance with the 2003 National Environmental Laboratory Accreditation Conference (NELAC) standards and ISO/IEC Guide 17025 (2005). In addition, the policies and procedures outlined in this manual are compliant with TestAmerica's Corporate Quality Management Plant, CA-Q-M-002, (CQMP) and the various accreditation and certification programs listed in Appendix 7 (3). The CQMP provides a summary of TestAmerica's quality and data integrity system. It contains requirements and general guidelines under which all TestAmerica facilities shall conduct their operations. The relevant NELAC section is included in the heading of each QAM section.

The QAM has been prepared to be consistent with the requirements of the following documents:

- EPA 600/4-79-019, *Handbook for Analytical Quality Control in Water and Wastewater Laboratories*, EPA, March 1979.
- Test Methods for Evaluating Solid Waste Physical/Chemical Methods (SW846), Third Edition, September 1986, Final Update I, July 1992, Final Update IIA, August 1993, Final Update II, September 1994; Final Update IIB, January 1995; Final Update III, December 1996; Final Update IV, January 2008.
- U.S. Department of Defense, *Quality Systems Manual for Environmental Laboratories*, Version 4.1, April 2009.
- Federal Register, 40 CFR Parts 136, 141, 172, 173, 178, 179 and 261.
- U.S. Department of Defense, *Quality Systems Manual for Environmental Laboratories*, Final Version 3, January 2006.
- Toxic Substances Control Act (TSCA).

3.2 TERMS AND DEFINITIONS

A Quality Assurance Program is a company-wide system designed to ensure data produced by the laboratory conforms to the standards set by state and/or federal regulations. The program functions at the management level through company goals and management policies, and at the analytical level through Standard Operating Procedures (SOPs) and quality control. The TestAmerica program is designed to minimize systematic error, encourage constructive, documented problem solving, and provide a framework for continuous improvement within the organization.

Refer to Appendix 6 (2) for the Glossary/Acronyms.

3.3 SCOPE / FIELDS OF TESTING

The laboratory analyzes a broad range of environmental and industrial samples every month. Sample matrices vary among effluent water, groundwater, hazardous waste, sludge, wipes, and soils. The Quality Assurance Program contains specific procedures and methods to test samples of differing matrices for chemical, physical and biological parameters. The Program also contains guidelines on maintaining documentation of analytical process, reviewing results, servicing clients and tracking samples through the laboratory. The technical and service requirements of all requests to provide analyses are thoroughly evaluated before commitments are made to accept the work. Measurements are made using published reference methods or methods developed and validated by the laboratory.

The methods covered by this manual include the most frequently requested methodologies needed to provide analytical services in the United States and its territories. The specific list of test methods used by the laboratory can be found in Appendix 4. The approach of this manual is to define the minimum level of quality assurance and quality control necessary to meet requirements. All methods performed by the laboratory shall meet these criteria as appropriate. In some instances, quality assurance project plans (QAPPs), project specific data quality objectives (DQOs) or local regulations may require criteria other than those contained in this manual. In these cases, the laboratory must abide by the requested criteria following review and acceptance of the requirements by the Laboratory Director/Manager, the Quality Assurance (QA) Manager, and the Technical Director. In some cases, QAPPs and DQOs may specify less stringent requirements. The Laboratory Director and the QA Manager must determine if it is in the lab's best interest to follow the less stringent requirements.

- Specific requirements delineated in project plans may supersede general quality requirements described in this manual. Ohio VAP requirements are listed throughout the document.

3.4 MANAGEMENT OF THE MANUAL

3.4.1 Review Process

This manual is reviewed annually by senior laboratory management to assure that it reflects current practices and meets the requirements of the laboratory's clients and regulators as well as the CQMP. Occasionally, the manual may need changes in order to meet new or changing regulations and operations. The QA Manager must review the changes in the normal course of business and incorporate changes into revised sections of the document. All updates must be reviewed by the senior laboratory management staff. The laboratory updates and approves such changes according to our Document Control and Updating Procedures (refer to SOP NC-QA-27 Preparation and Management of SOPs).

SECTION 4

ORGANIZATION AND MANAGEMENT (NELAC 5.4.1)

4.1 OVERVIEW

TestAmerica North Canton is a local operating unit of TestAmerica Laboratories, Inc. The organizational structure, responsibilities, and authorities of the corporate staff of TestAmerica Laboratories, Inc. are presented in the CQMP. The laboratory has day-to-day independent operational authority overseen by corporate officers (e.g., President, Chief Operating Officer, Corporate Quality Assurance, Corporate Quality Director, etc.). The laboratory operational and support staff work under the direction of the Laboratory Director. The organizational structure for both Corporate and TestAmerica North Canton is presented in Figure 4-1 Employee names are provided to demonstrate range and size of departments however the actual staff members may vary over time. The most current Organization Chart may be obtained from Quality Assurance Manager or Laboratory Director. .

4.2 ROLES AND RESPONSIBILITIES

In order for the Quality Assurance Program to function properly, all members of the staff must clearly understand and meet their individual responsibilities as they relate to the quality program. The following descriptions briefly define each role in its relationship to the Quality Assurance Program. More extensive job descriptions are maintained by laboratory management.

4.2.1 Quality Assurance Program

The responsibility for quality lies with every employee of the laboratory. All employees have access to the QAM, are trained to this manual, and are responsible for knowing the content of this manual and upholding the standards therein. Each person carries out his/her daily tasks in a manner consistent with the goals and in accordance with the procedures in this manual and the laboratory's SOPs. Role descriptions for Corporate personnel are defined in the CQMP. This manual is specific to the operations of TestAmerica North Canton laboratory.

North Canton Laboratory Key Personnel

Name	Position
Rusty Vicinie	General Manager, NE Region
Opal Davis-Johnson	Laboratory Director
Raymond Ridsen	Operations Manager
Dorothy Leeson	Quality Assurance Manager
Mark Bruce	Technical Director

Rebecca Strait	Client Services Director
Steve Jackson	Regional Safety Director, Waste Management Supervisor
Tammy Tokos	Reporting Group Leader
Olguita Colon	General Chemistry Group Leader
Will Cordell	Field Analytical Group Leader
Steve Earle	Extractions Group Leader
Al Haidet	Shipping Group Leader
Dave Heakin	GC Volatiles Group Leader
Tom Hula	GC/MS Semivolatiles Group Leader
John McFadden	Sample Control Group Leader
Darren Miller	Maintenance Group Leader
Roger Toth	Metals Group Leader
Carolynne Roach	GC Semivolatiles Group Leader
Tom Stiller	GC/MS Volatiles Group Leader
Patrick O'Meara	Project Management Group Leader

4.2.2 **Quality Assurance (QA) Manager**

The QA Manager has responsibility and authority to ensure the continuous implementation of the quality system

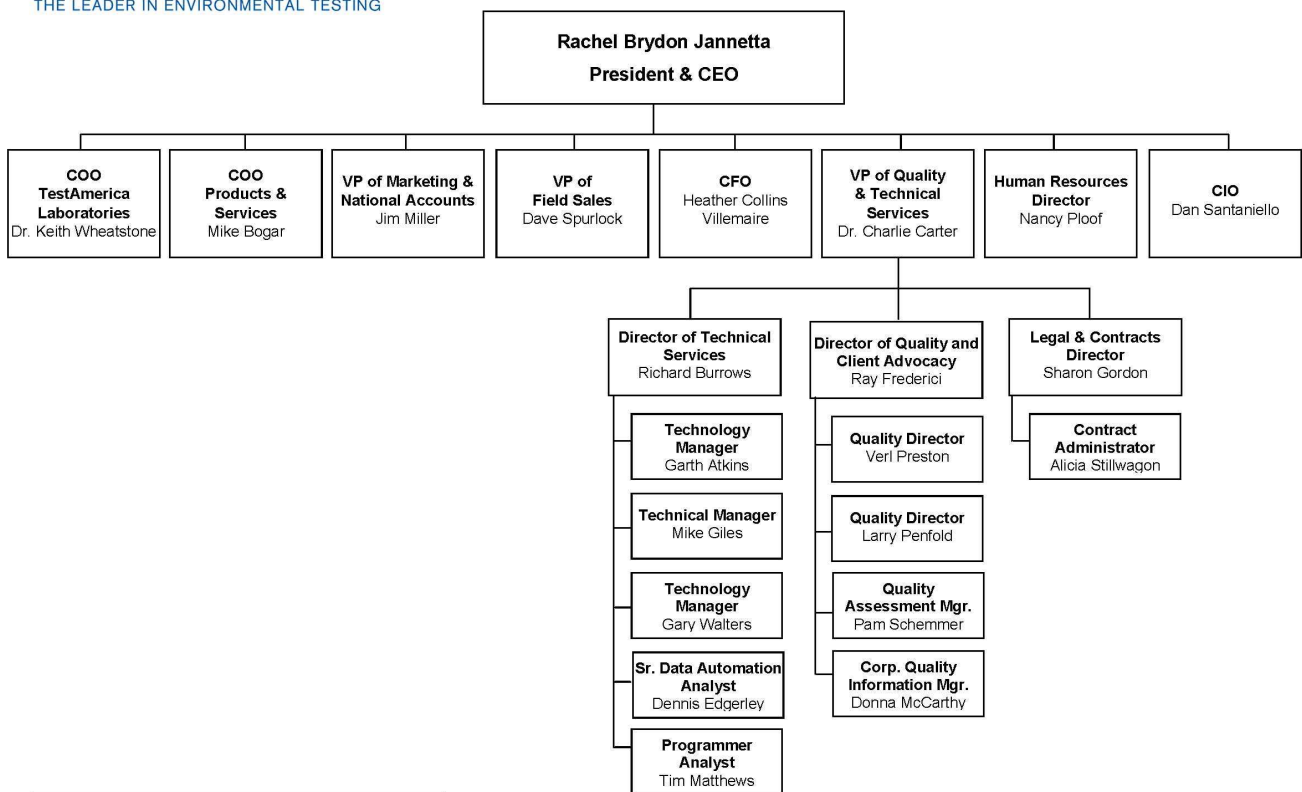
- Ensuring Communication & monitoring standards of performance to ensure that systems are in place to produce the level of quality as defined in this document.
- Notifying laboratory management of deficiencies in the quality system and ensuring corrective action is taken. Procedures that do not meet the standards set forth in the QAM or laboratory SOPs are temporarily suspended following the procedures outlined in Section 12.
- Evaluation of the thoroughness and effectiveness of training.

4.3 **DEPUTIES**

The following table defines who assumes the responsibilities of key personnel in their absence:

Key Personnel	Deputy
Laboratory Director	Technical Director
Quality Assurance Manager	Quality Assurance Specialist
Technical Director	Quality Assurance Manager
EHS Coordinator	Operations Manager

Figure 4-1. Corporate and Laboratory Organization Charts

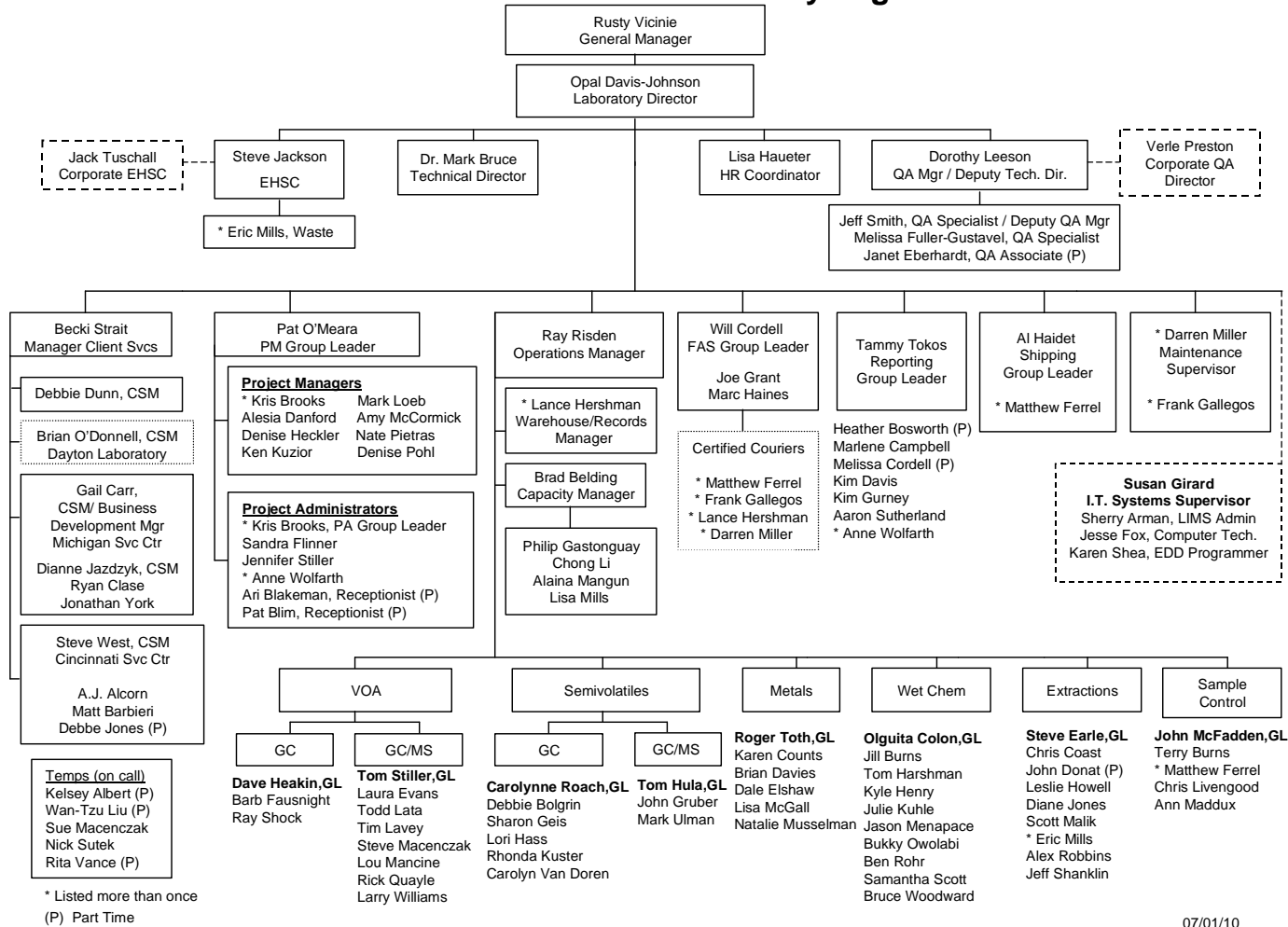


Note: QA Managers and Safety Coordinators in all laboratories and facilities have a dotted line reporting relationship to Corporate QA and EHS.

May 2010

North Canton Lab Org Chart

TestAmerica North Canton Laboratory Organization



07/01/10

SECTION 5

QUALITY SYSTEM (NELAC 5.4.2)

5.1 QUALITY POLICY STATEMENT

It is TestAmerica's policy to:

- ❖ Provide data of known quality to its clients by adhering to approved methodologies, regulatory requirements, and the QA/QC protocols.
- ❖ Effectively manage all aspects of the laboratory and business operations by the highest ethical standards.
- ❖ Continually improve systems and provide support to quality improvement efforts in laboratory, administrative, and managerial activities. TestAmerica recognizes that the implementation of a Quality Assurance program requires management's commitment and support as well as the involvement of the entire staff.
- ❖ Provide clients with the highest level of professionalism and the best service practices in the industry.
- ❖ To comply with the ISO/IEC 17025:2005 International Standard and to continually improve the effectiveness of the management system.

Every staff member at the laboratory plays an integral part in quality assurance and is held responsible and accountable for the quality of their work. It is, therefore, required that all laboratory personnel are trained and agree to comply with applicable procedures and requirements established by this document.

5.2 ETHICS AND DATA INTEGRITY

TestAmerica is committed to ensuring the integrity of its data and meeting the quality needs of its clients. The elements of the TestAmerica Ethics and Data Integrity Program include:

- An Ethics Policy (Corporate Policy CA-L-P-001) and Employee Ethics Statements (Appendix 1)
- Ethics and Compliance Officers (ECOs)
- A training program
- Self-governance through disciplinary action for violations
- A confidential mechanism for anonymously reporting alleged misconduct and a means for conducting internal investigations of all alleged misconduct (Corporate SOP CA-L-S-001)
- Procedures and guidance for recalling data if necessary (Corporate SOP CA-L-S-001)

- Effective external and internal monitoring system that includes procedures for internal audits (Section 16)
- Produce results, which are accurate and include QA/QC information that meets client pre-defined Data Quality Objectives (DQOs).
- Present services in a confidential, honest and forthright manner.
- Provide employees with guidelines and an understanding of the Ethical and Quality Standards of our Industry.
- Operate our facilities in a manner that protects the environment and the health and safety of employees and the public.
- Obey all pertinent federal, state and local laws and regulations and encourage other members of our industry to do the same.
- Educate clients as to the extent and kinds of services available.
- Assert competency only for work for which adequate personnel and equipment are available and for which adequate preparation has been made.
- Promote the status of environmental laboratories, their employees, and the value of services rendered by them.

5.3 QUALITY SYSTEM SUPPORTING DOCUMENTATION

The laboratory's Quality System is communicated through a variety of documents

- Quality Assurance Manual – Each laboratory has a lab-specific Quality Assurance Manual.
- Corporate SOPs and Policies - Corporate SOPs and Policies are developed for use by all relevant laboratories. They are incorporated into the laboratory's normal SOP distribution, training and tracking system. Corporate SOPs may be general or technical.
- Work Instructions - A subset of procedural steps, tasks or forms associated with an operation of a management system, e.g., checklists, preformatted bench sheets, forms.
- Laboratory SOPs – General and technical
- Corporate Quality Policy Memorandums
- Laboratory QA/QC Policy Memorandums

5.3.1 Order of Precedence

In the event of a conflict or discrepancy between policies, the order of precedence is as follows:

- Corporate Quality Policy Memorandum –
- Corporate Quality Management Plan (CQMP)
- Corporate SOPs and Policies
- Laboratory QA/QC Policy Memorandum
- Laboratory Quality Assurance Manual (QAM)
- Laboratory SOPs and Policies

- Other: Work Instructions (WI), memos, flow charts, etc.

Note: The laboratory's has the responsibility and authority to operate in compliance with regulatory requirements of the jurisdiction in which the work is performed. Where the CQMP conflicts with those regulatory requirements, the regulatory requirements of the jurisdiction shall hold primacy. The laboratory's (QAM) shall take precedence over the CQMP in those cases. Any regulatory requirements (e.g.; Ohio VAP, CT RCP, etc) provided in the laboratory specific documents (i.e., QAM and SOPs) take precedence over any policies provided in corporate documents.

5.4 QA/QC OBJECTIVES FOR THE MEASUREMENT OF DATA

Quality Assurance (QA) and Quality Control (QC) are activities undertaken to achieve the goal of producing data that accurately characterize the sites or materials that have been sampled. Quality Assurance is generally understood to be more comprehensive than Quality Control. Quality Assurance can be defined as the integrated system of activities that ensures that a product or service meets defined standards.

Quality Control is generally understood to be limited to the analyses of samples and to be synonymous with the term "*analytical quality control*". QC refers to the routine application of statistically based procedures to evaluate and control the accuracy of results from analytical measurements. The QC program includes procedures for estimating and controlling precision and bias and for determining reporting limits.

Request for Proposals (RFPs) and Quality Assurance Project Plans (QAPP) provide a mechanism for the client and the laboratory to discuss the data quality objectives in order to ensure that analytical services closely correspond to client needs. The client is responsible for developing the QAPP. In order to ensure the ability of the laboratory to meet the Data Quality Objectives (DQOs) specified in the QAPP, clients are advised to allow time for the laboratory to review the QAPP before being finalized. Additionally, the laboratory must provide support to the client for developing the sections of the QAPP that concern laboratory activities.

Historically, laboratories have described their QC objectives in terms of precision, accuracy, representativeness, comparability, completeness, selectivity and sensitivity (PARCCSS). Equations to derive relevant QC objectives can be found in the method specific SOPs.

5.4.1 Precision

The laboratory objective for precision is to meet the performance for precision demonstrated for the methods on similar samples and to meet data quality objectives of the EPA and/or other regulatory programs. Precision is defined as the degree of reproducibility of measurements under a given set of analytical conditions (exclusive of field sampling variability). Precision is documented on the basis of replicate analysis, usually duplicate or matrix spike (MS) duplicate samples.

5.4.2 Accuracy

The laboratory objective for accuracy is to meet the performance for accuracy demonstrated for the methods on similar samples and to meet data quality objectives of the EPA and/or other

regulatory programs. Accuracy is defined as the degree of bias in a measurement system. Accuracy may be documented through the use of laboratory control samples (LCS) and/or MS. A statement of accuracy is expressed as an interval of acceptance recovery about the mean recovery.

5.4.3 Representativeness

The laboratory objective for representativeness is to provide data which is representative of the sampled medium. Representativeness is defined as the degree to which data represent a characteristic of a population or set of samples and is a measurement of both analytical and field sampling precision. The representativeness of the analytical data is a function of the procedures used in procuring and processing the samples. The representativeness can be documented by the relative percent difference between separately procured, but otherwise identical samples or sample aliquots.

The representativeness of the data from the sampling sites depends on both the sampling procedures and the analytical procedures. The laboratory may provide guidance to the client regarding proper sampling and handling methods in order to assure the integrity of the samples.

5.4.4 Comparability

The comparability objective is to provide analytical data for which the accuracy, precision, representativeness and reporting limit statistics are similar to these quality indicators generated by other laboratories for similar samples, and data generated by the laboratory over time.

The comparability objective is documented by inter-laboratory studies carried out by regulatory agencies or carried out for specific projects or contracts, by comparison of periodically generated statements of accuracy, precision and reporting limits with those of other laboratories.

5.4.5 Completeness

The completeness objective for data is 90% (or as specified by a particular project) expressed as the ratio of the valid data to the total data over the course of the project. Data will be considered valid if they are adequate for their intended use. Data usability must be defined in a QAPP, project scope or regulatory requirement. Data validation is the process for reviewing data to determine its usability and completeness. If the completeness objective is not met, actions will be taken internally and with the data user to improve performance. This may take the form of an audit to evaluate the methodology and procedures as possible sources for the difficulty or may result in a recommendation to use a different method.

5.4.6 Selectivity

Selectivity is defined as the capability of a test method or instrument to respond to a target substance or constituent in the presence of non-target substances. Target analytes are separated from non-target constituents and subsequently identified/detected through one or more of the following, depending on the analytical method: extractions (separation), digestions (separation), inter-element corrections (separation), use of matrix modifiers (separation),

specific retention times (separation and identification), confirmations with different columns or detectors (separation and identification), specific wavelengths (identification), specific mass spectra (identification), specific electrodes (separation and identification), etc.

5.4.7 Sensitivity

Sensitivity refers to the amount of analyte necessary to produce a detector response that can be reliably detected (Method Detection Limit) or quantified (Reporting Limit).

5.5 CRITERIA FOR QUALITY INDICATORS

The laboratory maintains a Control Limit Report that summarizes the precision and accuracy acceptability limits for performed analyses. This summary includes an effective date, is updated each time new limits are generated, and are managed by the laboratory's QA Department. Unless otherwise noted, limits within these tables are laboratory generated. Some acceptability limits are derived from US EPA methods when they are required. Where U.S. EPA method limits are not required, the laboratory has developed limits from evaluation of data from similar matrices. Criteria for development of control limits are contained in NC-QA-018 Statistical Evaluation of Data and Development of Control Charts and in Section 24).

5.6 STATISTICAL QUALITY CONTROL

Statistically-derived precision and accuracy limits are required by selected methods (such as SW-846) and programs. The laboratory routinely utilizes statistically-derived limits to evaluate method performance and determine when corrective action is appropriate. The analysts are instructed to use the current limits in the laboratory (dated and approved by the Group Leader and QA Manager) and entered into the Laboratory Information Management System (LIMS). The Quality Assurance Department maintains an archive of all limits used within the laboratory. If a method defines the QC limits, the method limits are used.

If a method requires the generation of historical limits, the lab develops such limits from recent data in the QC database of the LIMS following the guidelines described in Section 25. All calculations and limits are documented and dated when approved and effective. On occasion, a client requests contract-specified limits for a specific project.

Surrogate recoveries are determined for a specific time period as defined above. The resulting ranges are entered in LIMS.

Current QC limits are entered and maintained in the LIMS analyte database. As sample results and the related QC are entered into LIMS, the sample QC values are compared with the limits in LIMS to determine if they are within the acceptable range. The analyst then evaluates if the sample needs to be rerun or re-extracted/rerun or if a comment should be added to the report explaining the reason for the QC outlier.

5.6.1 QC Charts

In-house limits for all QC data must be evaluated and compared to the limits published in the methods for applicable matrices. Method limits must be employed until sufficient QC data are acquired. A minimum of 20 to 30 data points are recommended to establish the in-house QC limits. Calculated results of the QC (LCS) samples are evaluated by comparing against control limits (3-sigma).

Control charts are used to develop control limits, trouble-shoot analytical problems, and, in conjunction with the non-conformance system, to monitor for trends. Program-specific data analysis requirements for control charts are followed as required for data generated under those programs. These additional requirements shall be documented in a QAPP or QAS.

5.7 QUALITY SYSTEM METRICS

In addition to the QC parameters discussed above, the entire Quality System is evaluated on a monthly basis through the use of specific metrics (refer to Section 16). These metrics are used to drive continuous improvement in the laboratory's Quality System.

SECTION 6

DOCUMENT CONTROL (NELAC 5.4.3)

6.1 OVERVIEW

The QA Department is responsible for the control of documents used in the laboratory to ensure that approved, up-to-date documents are in circulation and out-of-date (obsolete) documents are archived or destroyed. The following documents, at a minimum, must be controlled at each laboratory Facility:

- Laboratory Quality Assurance Manual
- Laboratory Standard Operating Procedures (SOP)
- Laboratory Policies
- Work Instructions and Forms
- Corporate Policies and Procedures distributed outside the intranet

Corporate Quality posts Corporate Manuals, SOPs, Policies, Work Instructions, White Papers, and Training Materials on the company intranet site. These Corporate documents are only considered controlled when they are read on the company intranet site. Printed copies are considered uncontrolled unless the laboratory physically distributes them as controlled documents. A detailed description of the procedure for issuing, authorizing, controlling, distributing, and archiving Corporate documents is found in Corporate SOP CW-Q-S-001, Corporate Document Control and Archiving. The laboratory's internal document control procedure is defined in SOP NC-QA-027, Preparation and Management of Standard Operating Procedures.

The laboratory QA Department also maintains access to various references and document sources integral to the operation of the laboratory. This includes reference methods and regulations. The laboratory also maintains instrument manuals (hard or electronic copies).

The laboratory maintains control of records for raw analytical data and supporting records such as audit reports and responses, logbooks, standard logs, training files, MDL studies, Proficiency Testing (PT) studies, certifications and related correspondence, and Corrective Action reports. Raw analytical data consists of bound logbooks, instrument printouts, any other notes, magnetic media, electronic data and final reports.

6.2 DOCUMENT APPROVAL AND ISSUE

The pertinent elements of a document control system for each document include a unique document title and number, the number of pages of the item, the effective date, revision number, and the laboratory name. The QA Department is responsible for the maintenance of this system.

Controlled documents are authorized by the QA Department and other management. In order to develop a new document, a staff member submits an electronic draft to the QA Department

for suggestions and approval before use. Upon approval, QA personnel add the identifying version information to the document, and retains the official document on file. The official document is provided to all applicable operational units (may include electronic access). Controlled documents are identified as such and records of their distribution are kept by the QA Department. Document control may be achieved by either electronic or hardcopy distribution.

The QA Department maintains a list of the official versions of controlled documents.

Quality System Policies and Procedures must be reviewed at a minimum of every 24 months, and revised as appropriate. For procedures associated with DoD and Ohio VAP project work, applicable SOPs and Policies are reviewed every 12 months. Changes to documents occur when a procedural change warrants.

6.3 PROCEDURES FOR DOCUMENT CONTROL POLICY

For changes to the QA Manual, refer to SOPs NC-QA-019 and CW-Q-S-001. Uncontrolled copies must not be used within the laboratory. Previous revisions and back-up data are stored by the QA/QC Department.

For changes to SOPs, refer to Corporate SOP CW-Q-S-002, Writing a Standard Operating Procedure (SOP), and SOP NC-QA-027, Preparation and Management of Standard Operating Procedures.

Forms, worksheets, Work Instructions, and information are organized by department in the QA office. Electronic versions are kept on a hard drive in the QA department; hard copies are kept in QA files. The procedure for the care of these documents is in SOP NC-QA-027.

6.4 OBSOLETE DOCUMENTS

All invalid or obsolete documents are removed, or otherwise prevented from unintended use. The laboratory has specific procedures as described above to accomplish this. In general, obsolete documents are collected from employees according to distribution lists and are marked obsolete on the cover or destroyed. At least one copy of the obsolete document is archived according to SOP NC-QA-027.

SECTION 7

SERVICE TO THE CLIENT (NELAC 5.4.7)

7.1 OVERVIEW

The laboratory has established procedures for the review of work requests and contracts, oral or written. The procedures include evaluation of the laboratory's capability and resources to meet the contract's requirements within the requested time period. All requirements, including the methods to be used, must be adequately defined, documented and understood. For many environmental sampling and analysis programs, testing design is site or program specific and does not necessarily "fit" into a standard laboratory service or product. It is the laboratory's intent to provide both standard and customized environmental laboratory services to our clients.

A thorough review of technical and QC requirements contained in contracts is performed to ensure project success. The appropriateness of requested methods, and the lab's capability to perform them must be established. Projects, proposals and contracts are reviewed for adequately defined requirements and the laboratory's capability to meet those requirements. Alternate test methods that are capable of meeting the clients' requirements may be proposed by the lab. A review of the lab's capability to analyze non-routine analytes is also part of this review process.

All projects, proposals and contracts are reviewed for the client's requirements in terms of compound lists, test methodology requested, sensitivity (detection and reporting levels), accuracy, and precision requirements (Percent Recovery and RPD). The reviewer ensures that the laboratory's test methods are suitable to achieve these regulatory and client requirements and that the laboratory holds the appropriate certifications and approvals to perform the work. The laboratory and any potential subcontract laboratories must be certified, as required, for all proposed tests.

The laboratory must determine if it has the necessary physical, personnel and information resources to meet the contract, and if the personnel have the expertise needed to perform the testing requested. Each proposal is checked for its impact on the capacity of the laboratory's equipment and personnel. As part of the review, the proposed turnaround time must be checked for feasibility.

Electronic or hard-copy deliverable requirements are evaluated against the laboratory's capacity for production of the documentation.

If the laboratory cannot provide all services but intends to subcontract such services, whether to another TestAmerica facility or to an outside firm, this must be documented and discussed with the client prior to contract approval (refer to Section 8 for Subcontracting Procedures).

The laboratory informs the client of the results of the review if it indicates any potential conflict, deficiency, lack of accreditation, or inability of the lab to complete the work satisfactorily. Any discrepancy between the client's requirements and the laboratory's capability to meet those requirements is resolved in writing before acceptance of the contract. It is necessary that the

contract be acceptable to both the laboratory and the client. Amendments initiated by the client and/or TestAmerica, are documented in writing.

All contracts, QAPPs, Sampling and Analysis Plans (SAPs), contract amendments, and documented communications become part of the project record.

The same contract review process used for the initial review is repeated when there are amendments to the original contract by the client, and the participating personnel are informed of the changes.

7.2 REVIEW SEQUENCE AND KEY PERSONNEL

Appropriate personnel must review the work request at each stage of evaluation.

For routine projects and other simple tasks, a review by the Project Manager (PM) is considered adequate. The PM confirms that the laboratory has any required certifications, that it can meet the clients' data quality and reporting requirements and that the lab has the capacity to meet the clients turn around needs. It is recommended that, where there is a sales person assigned to the account, an attempt should be made to contact that sales person to inform them of the incoming samples.

For new, complex or large projects, the opportunity is forwarded to a Customer Service Manager (CSM) for review. The CSM contacts the appropriate Sales Executive (National Account Manager, Key Account Executive, Regional Account Executive, and/or Program Manager) to determine which lab will receive the work based on the scope of work and other requirements, including certification, testing methodology, reporting specifications, and available capacity to perform the work. The contract review process is outlined in TestAmerica's Corporate SOP CA-L-P-002, Contract Compliance Policy.

This review encompasses all facets of the operation. The scope of work is distributed to the appropriate personnel, as needed based on scope of contract, to evaluate all of the requirements shown above (not necessarily in the order below):

- Legal & Contracts Director
- Laboratory Customer Service Manager
- Laboratory Operations Manager
- Laboratory and/or Corporate Technical Director
- Laboratory and/or Corporate Information Technology Managers/Directors
- Regional and/or National Account representatives
- Laboratory and/or Corporate Quality Assurance Managers
- Laboratory and/or Corporate Environmental Health and Safety Managers/Directors
- The Laboratory Director/Manager reviews the formal laboratory quote, and makes final acceptance for their facility.
- Based on the level of discount extended for the project, approval of the General Manager or Sales Director may also be required.

The Customer Service Manager or local Account Executive then submits the final proposal to the client.

In the event that one of the above personnel is not available to review the contract, his or her backup will fulfill the review requirements.

The Legal & Contracts Director (or their designee) maintains copies of all signed contracts. The Laboratory Director also maintains an electronic copy of any contract signed at the local level.

7.3 DOCUMENTATION

Appropriate records are maintained for every contract or work request. All stages of the contract review process are documented and include records of any significant changes. Documents are reviewed by the Laboratory Director and stored on the laboratory's public drive.

The contract must be distributed to and maintained by the Corporate Contracts Department and the applicable Account Executive. A copy of the contract must be filed electronically by the Laboratory Director. Quotes must be archived electronically in the laboratory quote module (TALs) or in the public shared drive if an off-TALs quote is submitted.

Records are maintained of pertinent discussions with a client relating to the client's requirements or the results of the work during the period of execution of the contract. The PM keeps email records or a phone log of conversations with the client.

7.3.1 Project-Specific Quality Planning

Communication of contract-specific technical and QC criteria is an essential activity in ensuring the success of site specific testing programs. To achieve this goal, the laboratory assigns a PM to each client. The PM is the first point of contact for the client. It is the PM's responsibility to ensure that project specific technical and QC requirements are effectively evaluated and communicated to the laboratory personnel before and during the project. QA department involvement may be needed to assist in the evaluation of custom QC requirements.

PM's are the primary client contact and they ensure resources are available to meet project requirements. Although PM's do not have direct reports or staff in production, they coordinate opportunities and work with laboratory management and supervisory staff to ensure available resources are sufficient to perform work for the client's project. Project management is positioned between the client and laboratory resources.

Prior to work on a new project, the dissemination of project information and/or project opening meetings may occur to discuss schedules and unique aspects of the project. Items to be discussed may include the project technical profile, turnaround times, holding times, methods, analyte lists, reporting limits, deliverables, sample hazards, or other special requirements. The PM introduces new projects to the laboratory staff through project kick-off meetings or to the supervisory staff during production meetings. These meetings provide direction to the laboratory staff in order to maximize production and client satisfaction, while maintaining quality. In addition,

project notes may be associated with each sample batch as a reminder upon sample receipt and analytical processing.

During the project, any change that may occur within an active project is agreed upon between the client/regulatory agency and the PM/laboratory. These changes, e.g., use of a non-standard method or modification of a method, and approvals must be documented prior to implementation. Documentation pertains to any document, e.g., letter, e-mail, variance, contract addendum, which has been signed by both parties.

Such changes are also communicated to the laboratory. Project-specific changes made after samples are in-house are communicated through Change Order forms.

Programmatic and/or method changes are communicated via email transmittal and/or in meetings with the applicable Operations Managers. If the modification includes use of a non-standard method, or significant modification of a method, documentation of the modification is made in the case narrative of the applicable data report(s).

The laboratory strongly encourages client visits to the laboratory and for formal/informal information sharing session with employees in order to effectively communicate ongoing client needs as well as project specific details for customized testing programs.

7.4 SPECIAL SERVICES

The laboratory cooperates with clients and their representatives to monitor the laboratory's performance in relation to work performed for the client. It is the laboratory's goal to meet all client requirements in addition to statutory and regulatory requirements. The laboratory has procedures to ensure confidentiality to clients (Section 15 and 25).

Note: ISO 17025/NELAC 2003 states that a laboratory "shall afford clients or their representatives cooperation to clarify the client's request". This topic is discussed in Section 7.

The laboratory's standard procedures for reporting data are described in Section 25. Special services are also available and provided upon request. These services include:

- Reasonable access for our clients or their representatives to the relevant areas of the laboratory for the witnessing of tests performed for the client.
- Assist client-specified third-party data validators as specified in the client's contract.
- Supplemental information pertaining to the analysis of their samples. Note: An additional charge may apply for additional data/information that was not requested prior to the time of sample analysis or previously agreed upon.

7.5 CLIENT COMMUNICATION

Customer Service Managers (CSMs) and Project Managers (PMs) are the primary communication link to the clients. They must inform their clients of any delays in project completion as well as any non-conformances in either sample receipt or sample analysis. Project Management must maintain ongoing client communication throughout the entire client project.

Technical Directors, Operation Manager, or Group Leaders are available to discuss any technical questions or concerns the client may have.

7.6 REPORTING

The laboratory works with our clients to produce any special communication reports required by the contract.

7.7 CLIENT SURVEYS

The laboratory assesses both positive and negative client feedback. The results are used to improve overall laboratory quality and client service.

TestAmerica Sales and Marketing teams periodically develop lab and client-specific surveys to assess client satisfaction.

SECTION 8

SUBCONTRACTING OF TESTS (NELAC 5.4.5)

8.1 OVERVIEW

For the purpose of this quality manual, the phrase subcontract laboratory refers to a laboratory external to the TestAmerica Laboratories. The phrase “work sharing” refers to internal transfers of samples between the TestAmerica Laboratories. The term “outsourcing” refers to the act of subcontracting tests.

When contracting with our clients, the laboratory makes commitments regarding the services to be performed and the data quality for the results to be generated. When the need arises to outsource testing for our clients because project scope, changes in laboratory capabilities, capacity or unforeseen circumstances, we must be assured that the subcontractors or work sharing laboratories understand the requirements and must meet the same commitments we have made to the client. Refer to TestAmerica’s Corporate SOPs on Subcontracting Procedures (CA-L-S-002) and the Work Sharing Process SOP (CA-C-S-001).

When outsourcing analytical services, the laboratory must assure, to the extent necessary, that the subcontract or work sharing laboratory maintains a program consistent with the requirements of this document, the requirements specified in NELAC/ISO 17025 and/or the client’s Quality Assurance Project Plan (QAPP). All QC guidelines specific to the client’s analytical program are transmitted to the subcontractor and agreed upon before sending the samples to the subcontract facility. Additionally, work requiring accreditation must be placed with an appropriately accredited laboratory. The laboratory performing the subcontracted work must be identified in the final report, as must non-NELAC accredited work, where required.

For DOD projects, the subcontractor laboratories used must have an established and documented laboratory quality system that complies with DoD QSM requirements. The subcontractor laboratories are evaluated following the procedures outlined below and as seen in Figure 8-2. The subcontractor laboratory must receive project-specific approval from the DoD client before any samples are analyzed.

The QSM has five specific requirements for subcontracting:

1. Subcontractor laboratories must have an established laboratory quality system that complies with the QSM.
2. Subcontractor laboratories must be approved by the specific DoD component laboratory approval process.
3. Subcontractor laboratories must demonstrate the ability to generate acceptable results from the analysis of PT samples, subject to availability, using each applicable method, in the specified matrix, and provide appropriate documentation to the DoD client.

4. Subcontractor laboratories must receive project-specific approval from the DoD client before any samples are analyzed.
5. Subcontractor laboratories are subject to project-specific, on-site assessments by the DoD client or their designated representatives.

Project Managers (PMs) or Customer Service Managers (CSM) for the Export Lab are responsible for obtaining client approval prior to outsourcing any samples. The laboratory must advise the client of a subcontract or work sharing arrangement in writing and when possible approval from the client must be retained in the project folder.

Note: In addition to the client, some regulating agencies, such as the US Army Corps of Engineers and the USDA, require notification prior to placing such work.

8.2 QUALIFYING AND MONITORING SUBCONTRACTORS

Whenever a PM or Customer Service Manager (CSM) becomes aware of a client requirement or laboratory need where samples must be outsourced to another laboratory, the other laboratory(s) shall be selected based on the following:

- The first priority is to attempt to place the work in a qualified TestAmerica laboratory
- Firms specified by the client for the task. (Documentation that a subcontractor was designated by the client must be maintained with the project file. This documentation can be as simple as placing a copy of an e-mail from the client in the project folder.)
- Firms listed as pre-qualified and currently under a subcontract with TestAmerica. A listing of all approved subcontracting laboratories and supporting documentation is available on the TestAmerica intranet site. Verify necessary accreditation, where applicable (e.g., on the subcontractors NELAC, A2LAA accreditation or State Certification.
- Firms identified in accordance with the company's Small Business Subcontracting program as small, women-owned, veteran-owned and/or minority-owned businesses
- NELAC or A2LA-accredited laboratories
- In addition, the firm must hold the appropriate certification to perform the work required

All TestAmerica Laboratories are pre-qualified for work sharing, provided they hold the appropriate accreditations, can adhere to the project/program requirements, and the client approved sending samples to that laboratory. The client must provide acknowledgement that the samples can be sent to that facility (an e-mail is sufficient documentation or if acknowledgement is verbal, the date, time, and name of person providing acknowledgement must be documented). The originating laboratory is responsible for communicating all technical, quality, and deliverable requirements as well as other contract needs. Refer to Corporate SOP CA-C-S-001, Work Sharing Process.

When the potential subcontract laboratory has not been previously approved, CSMs or PMs may nominate a laboratory as a subcontractor based on need. The decision to nominate a laboratory must be approved by the Laboratory Director/Manager. The Laboratory Director/Manager requests that the QA Manager begin the process of approving the subcontract

laboratory as outlined in Corporate SOP CA-L-S-002, Subcontracting Procedures. The client must provide acknowledgement that the samples can be sent to that facility. (An e-mail is sufficient documentation; or if acknowledgement is verbal, the date, time, and name of person providing acknowledgement must be documented.)

- 8.2.1** Once the appropriate accreditation and legal information is received by the laboratory, it is evaluated for acceptability (where applicable) and forwarded to Corporate Contracts for formal contracting with the laboratory. They must add the lab to the approved list on the intranet site, along with the associated documentation and notify the Finance Group for J.D.Edwards.
- 8.2.2** The client must assume responsibility for the quality of the data generated from the use of a subcontractor they have requested the lab to use. The qualified subcontractors on the intranet site are to meet minimal standards. TestAmerica does not certify laboratories. The subcontractor is on our approved list, and can only be recommended to the extent that we would use them.
- 8.2.3** The status and performance of qualified subcontractors must be monitored periodically by the Corporate Contracts and/or Quality Departments. Any problems identified must be brought to the attention of TestAmerica's Corporate Finance or Corporate Quality personnel.
- Complaints must be investigated. Documentation of the complaint, investigation, and corrective action must be maintained in the subcontractor file on the intranet site. Complaints are posted using the Vendor Performance Report.
 - Information must be updated on the intranet when new information is received from the subcontracted laboratories.
 - Subcontractors in good standing must be retained on the intranet listing. The QA Manager must notify all TestAmerica laboratories, Corporate Quality, and Corporate Contracts if any laboratory requires removal from the intranet site. This notification must be posted on the intranet site and e-mailed to all Lab Directors/Managers, QA Managers, and Sales Personnel.

8.3 OVERSIGHT AND REPORTING

The CSM or PM must request that the selected subcontractor be presented with a subcontract, if one is not already executed between the laboratory and the subcontractor. The subcontract must include terms which flow down the requirements of our clients, either in the subcontract itself or through the mechanism of work orders relating to individual projects. A standard subcontract and the Lab Subcontractor Vendor Package (posted on the intranet) can be used to accomplish this, and the Legal & Contracts Director can tailor the document or assist with negotiations, if needed. The PM or CSM responsible for the project must advise and obtain client consent to the subcontract as appropriate, and provide the scope of work to ensure that the proper requirements are made a part of the subcontract and are made known to the subcontractor.

Prior to sending samples to the subcontracted laboratory, the PM confirms their certification status to determine if it's current and scope-inclusive. For TestAmerica Laboratories, certifications can be viewed on the company's TotalAccess Database.

The Sample Control Department is responsible for ensuring compliance with QA requirements and applicable shipping regulations when shipping samples to a subcontracted laboratory.

All subcontracted samples must be accompanied by a Chain of Custody (COC). A copy of the original COC sent by the client must be included with all samples subbed within the TestAmerica.

Through communication with the subcontracted laboratory, the PM monitors the status of the subcontracted analyses, facilitates successful execution of the work, and ensures the timeliness and completeness of the analytical report.

Non-NELAC accredited work must be identified in the subcontractor's report as appropriate. If NELAC accreditation is not required, the report does not need to include this information.

Reports submitted from subcontractor laboratories are not altered and are included in their original form in the final project report. This clearly identifies the data as being produced by a subcontractor facility. If subcontract laboratory data is incorporated into the laboratory EDD, i.e., imported, the report must explicitly indicate the specific lab that produced the data and identify the specific methods and samples.

Note: The results submitted by a TestAmerica work-sharing laboratory may be transferred electronically and the results reported by the TestAmerica work-sharing lab are identified on the final report. The report must explicitly indicate which lab produced the data for which methods and samples. The final report must include a copy of the completed COC for all work sharing reports.

8.4 CONTINGENCY PLANNING

The Laboratory Director/Manager may waive the full qualification of a subcontractor process temporarily to meet emergency needs. In the event this provision is utilized, the QA Manager will be required to verify certifications. The comprehensive approval process must then be initiated within 30 calendar days of subcontracting.

Figure 8-1. Example - Client-Approved Subcontractor Form

Client Information:

Client Name & Account Number: _____

Client Contact: _____

Client Address: _____

Project Information: (Please choose all applicable.)

❖ Certification required: ☐ State ☐ NELAC ☐ A2LA ☐ Method_____

☐ Target compound_____ ☐ Other_____ ☐ N/A

❖ Required Turn around time (method provisional)_____

Subcontractor's Information:

Subcontractor's Name: _____

Subcontractor's Contact: _____

Subcontractor's Email: _____

Subcontractor's Address: _____

Subcontractor's Phone Number: _____

Analytical Test/Compound/Method to be subcontracted: _____

Certification Statement:

I hereby give **[Insert Lab Name]** permission to use the above noted subcontractor for the above noted testing procedures/methods. I realize that the above subcontractor will be held liable for the validity of the above mentioned testing procedures/methods. All subcontractors shall meet the requirements as spelled out in project information and will follow all analytical holding times and turn around times for analytical reports. The subcontract laboratory, and not TestAmerica, will be held liable for liquidated damages for delays in subcontracted analytical reports and/or electronic data deliverables.

Client Signature

Date

SECTION 9

PURCHASING SERVICES AND SUPPLIES (NELAC 5.4.6)

9.1 OVERVIEW

Evaluation and selection of suppliers and vendors is performed, in part, on the basis of the quality of their products, their ability to meet the demand for their products on a continuous and short term basis, the overall quality of their services, their past history, and competitive pricing. This is achieved through evaluation of objective evidence of quality furnished by the supplier, which can include certificates of analysis, recommendations, and proof of historical compliance with similar programs for other clients. To ensure that quality critical consumables and equipment conform to specified requirements, which may affect quality, all purchases from specific vendors are approved by a member of the supervisory or management staff. Capital expenditures are made in accordance with the TestAmerica's Corporate Controlled Purchases Procedure, SOP CW-F-S-007.

Contracts must be signed in accordance with TestAmerica's Corporate Authorization Matrix Policy, Policy CW-F-P-002. Request for Proposals (RFP's) must be issued where more information is required from the potential vendors than just price. Process details are available in TestAmerica's Corporate Procurement and Contracts Policy (Policy CW-F-P-004). RFP's allow TestAmerica to determine if a vendor is capable of meeting requirements such as supplying all of the TestAmerica facilities, meeting required quality standards and adhering to necessary ethical and environmental standards. The RFP process also allows potential vendors to outline any additional capabilities they may offer.

9.2 GLASSWARE

Glassware used for volumetric measurements must be Class A or verified for accuracy according to laboratory procedure. Pyrex (or equivalent) glass must be used where possible. For safety purposes, thick-wall glassware must be used where available.

9.3 REAGENTS, STANDARDS & SUPPLIES

Purchasing guidelines for equipment and reagents must meet the requirements of the specific method and testing procedures for which they are being purchased. Solvents and acids are pre-tested in accordance with TestAmerica's Corporate SOP on Solvent and Acid Lot Testing and Approval, SOP CA-Q-S-001.

9.3.1 Purchasing

Chemical reagents, solvents, glassware, and general supplies are ordered as needed to maintain sufficient quantities on hand. Materials used in the analytical process must be of a known quality. The wide variety of materials and reagents available makes it advisable to specify recommendations for the name, brand, and grade of materials to be used in any

determination. This information is contained in the method SOP. The analyst may check the item out of the on-site consignment system that contains items approved for laboratory use

9.3.2 Receiving

It is the responsibility of the Warehouse Manager to receive the shipment. It is the responsibility of the analyst who ordered the materials to date the material when received. Once the ordered reagents or materials are received, the analyst compares the information on the label or packaging to the original order to ensure that the purchase meets the quality level specified. Material Safety Data Sheets (MSDSs) are kept on a backup disc located in the Wet Chemistry bullpen and available online through the Company's intranet website. Anyone may review these for relevant information on the safe handling and emergency precautions of on-site chemicals.

9.3.3 Specifications

All methods in use in the laboratory specify the grade of reagent that must be used in the procedure. If the quality of the reagent is not specified, it may be assumed that it is not significant in that procedure and, therefore, any grade reagent may be used. It is the responsibility of the analyst to check the procedure carefully for the suitability of grade of reagent. Specifications are listed in SOP NC-QA-017, Reagents and Standards.

Chemicals must not be used past the manufacturer's expiration date and must not be used past the expiration time noted in a method SOP. If expiration dates are not provided, the laboratory may contact the manufacturer to determine an expiration date.

The laboratory assumes a five-year expiration date on inorganic dry chemicals unless noted otherwise by the manufacturer or by the reference source method. Chemicals must not be used past the manufacturer's or SOPs expiration date unless "verified" (refer to Item 3 listed below).

- An expiration date cannot be extended if the dry chemical is discolored or appears otherwise physically degraded, the dry chemical must be discarded.
- Expiration dates can be extended if the dry chemical is found to be satisfactory based on acceptable performance of quality control samples (Continuing Calibration Verification (CCV), Blanks, Laboratory Control Sample (LCS), etc.).
- If the dry chemical is used for the preparation of standards, the expiration dates can be extended six months if the dry chemical is compared to an unexpired independent source in performing the method and the performance of the dry chemical is found to be satisfactory. The comparison must show that the dry chemical meets CCV limits. The comparison studies are maintained in the Standard Logbook in each laboratory group.

Wherever possible, standards must be traceable to national or international standards of measurement or to national or international reference materials. Records to that effect are available to the user.

Compressed gases in use are checked for pressure and secure positioning daily. The minimum total pressure must be 500 psig or the tank must be replaced. The quality of the gases must

meet method or manufacturer specification or be of a grade that does not cause any analytical interference.

Water used in the preparation of standards or reagents must have a conductivity of less than 1 mmho/cm (or specific resistivity of greater than 1.0 megaohm-cm) at 25°C. The specific conductivity is checked and recorded daily. If the water's conductivity is greater than the specified limit, the Operations Manager and appropriate Department Managers/ Group Leaders must be notified immediately in order to notify all departments, decide on cessation (based on intended use) of activities, and make arrangements for correction.

The laboratory may purchase reagent grade (or other similar quality) water for use in the laboratory. This water must be certified "clean" by the supplier for all target analytes or otherwise verified by the laboratory prior to use. This verification is documented.

Standard lots are verified before first time use if the laboratory switches manufacturers or has historically had a problem with the type of standard.

Purchased VOA vials must be certified clean and the certificates must be maintained. If uncertified VOA vials are purchased, all lots must be verified clean prior to use. This verification must be maintained.

9.3.4 Storage

Reagent and chemical storage is important from the aspects of both integrity and safety. Light-sensitive reagents may be stored in brown-glass containers. Storage conditions are per the Corporate Environmental Health & Safety Manual (Corporate Document CW-E-M-001) and method SOPs or manufacturer instructions.

9.4 PURCHASE OF EQUIPMENT/INSTRUMENTS/SOFTWARE

When a new piece of equipment is needed, either for additional capacity or for replacing inoperable equipment, the analyst or group leader makes a supply request to the Operations Manager and/or the Laboratory Director/Manager. If they agree with the request the procedures outlined in TestAmerica's Corporate Policy CA-T-P-001, Qualified Products List, are followed. A decision is made as to which piece of equipment can best satisfy the requirements. The appropriate written requests are completed, and Purchasing places the order.

Upon receipt of a new or used piece of equipment, an identification name is assigned, such as HP-20, added to the equipment list described in Section 21 that is maintained by the QA Department, and I.T. must be notified so they can synchronize the instrument for backups. Its capability is assessed to determine if it is adequate or not for the specific application. For instruments, a calibration curve is generated followed by MDLs, Demonstration of Capabilities (DOCs), and other relevant criteria (refer to Section 20). For software, its operation must be deemed reliable and evidence of instrument verification must be retained by the IT Department or QA Department. Software certificates supplied by the vendors are filed with the LIMS Administrator. The manufacturer's operation manual is retained at the bench.

9.5 SERVICES

Service to analytical instruments (except analytical balances) is performed on an as needed basis. Routine preventative maintenance is discussed in Section 20. The need for service is determined by analysts and/or Department Managers. The service providers that perform the services are approved by the Department Managers or Operations Manager.

9.6 SUPPLIERS

TestAmerica selects vendors through a competitive proposal / bid process, strategic business alliances or negotiated vendor partnerships (contracts). This process is defined in the Corporate Finance documents on Vendor Selection (SOP CW-F-S-018) and Procurement and Contracts Policy (Policy CW-F-P-004). The level of control used in the selection process is dependent on the anticipated spending amount and the potential impact on TestAmerica business. Vendors that provide test and measuring equipment, solvents, standards, certified containers, instrument related service contracts or subcontract laboratory services shall be subject to more rigorous controls than vendors that provide off-the-shelf items of defined quality that meet the end use requirements. The JD Edwards purchasing system includes all suppliers /vendors that have been approved for use.

Evaluation of suppliers is accomplished by ensuring the supplier ships the product or material ordered and that the material is of the appropriate quality. This is documented by signing off on packing slips or other supply receipt documents. The purchasing documents contain the data that adequately describe the services and supplies ordered.

Any issues of vendor performance are to be reported immediately by the laboratory staff to the Corporate Purchasing Group by completing a Vendor Performance Report (CW-F-WI-009).

The Corporate Purchasing Group must work through the appropriate channels to gather the information required to clearly identify the problem and must contact the vendor to report the problem and to make any necessary arrangements for exchange, return authorization, credit, etc.

As deemed appropriate, the Vendor Performance Reports must be summarized and reviewed to determine corrective action necessary, or service improvements required by vendors

The laboratory has access to a listing of all approved suppliers of critical consumables, supplies and services. This information is provided through the JD Edwards purchasing system.

9.6.1 New Vendor Procedure

TestAmerica employees who wish to request the addition of a new vendor must complete a J.D. Edwards Vendor Add Request Form.

New vendors are evaluated based upon criteria appropriate to the products or services provided as well as their ability to provide those products and services at a competitive cost. Vendors are also evaluated to determine if there are ethical reasons or potential conflicts of interest with TestAmerica employees that would make it prohibitive to do business with them as well as their

financial stability. The QA Department and/or the Laboratory Director are consulted with vendor and product selection that have an impact on quality.

SECTION 10

COMPLAINTS (NELAC 5.4.8)

10.1 OVERVIEW

The laboratory considers an effective client complaint handling process to be of significant business and strategic value. Listening to and documenting client concerns captures 'client knowledge' that enables our operations to continually improve processes and improving client satisfaction. An effective client complaint handling process also provides assurance to the data user that the laboratory will stand behind its data, service obligations and products.

A client complaint is any expression of dissatisfaction with any aspect of our business services, (e.g., communications, responsiveness, data, reports, invoicing and other functions) expressed by any party, whether received verbally or in written form. Client inquiries, complaints or noted discrepancies are documented, communicated to management, and addressed promptly and thoroughly.

The laboratory has procedures for addressing both external and internal complaints with the goal of providing satisfactory resolution to complaints in a timely and professional manner.

The nature of the complaint is identified, documented and investigated, and an appropriate action is determined and taken. In cases where a client complaint indicates that an established policy or procedure was not followed, the QA Department must evaluate whether a special audit must be conducted to assist in resolving the issue. A written confirmation or letter to the client, outlining the issue and response taken is recommended as part of the overall action taken.

The process of complaint resolution and documentation utilizes the procedures outlined in Section 12 (Corrective Actions) and is documented following SOPs NC-QA-029, Nonconformance and Corrective Action System, and CA-C-S-002, Complaint Handling and Service Recovery.

10.2 EXTERNAL COMPLAINTS

An employee that receives a complaint initiates the complaint resolution process by first documenting the complaint according to CA-C-S-002, Complaint Handling and Service Recovery.

Complaints fall into two categories: correctable and non-correctable. An example of a correctable complaint would be one where a report re-issue would resolve the complaint. An example of a non-correctable complaint would be one where a client complains that their data was repeatedly late. Non-correctable complaints must be reviewed for preventive action measures to reduce the likelihood of future occurrence and mitigation of client impact.

The general steps in the complaint handling process are:

- Receiving and Documenting Complaints
- Complaint Investigation and Service Recovery

- Process Improvement

The laboratory must inform the initiator of the complaint of the results of the investigation and the corrective action taken, if any.

10.3 INTERNAL COMPLAINTS

Internal complaints include, but are not limited to errors and non-conformances, training issues, internal audit findings, and deviations from methods. Corrective actions may be initiated by any staff member who observes a nonconformance and must follow the procedures outlined in Section 12. In addition, Corporate Management, Sales and Marketing, and Information Technology (IT) may initiate a complaint by contacting the laboratory or through the Corrective Action system described in Section 12.

10.4 MANAGEMENT REVIEW

The number and nature of client complaints is reported by the QA Manager to the laboratory and QA Director in the QA Monthly report. Monitoring and addressing the overall level and nature of client complaints and the effectiveness of the solutions is part of the Annual Management Review (Section 16)

SECTION 11

CONTROL OF NON-CONFORMING WORK (NELAC 5.4.9)

11.1 OVERVIEW

When data discrepancies are discovered or deviations and departures from laboratory SOPs, policies, and/or client requests have occurred, corrective action is taken immediately. First, the laboratory evaluates the significance of the nonconforming work. Then, a Corrective Action plan is initiated based on the outcome of the evaluation. If it is determined that the nonconforming work is an isolated incident, the plan could be as simple as adding a qualifier to the final results and/or making a notation in the case narrative. If it is determined that the nonconforming work is a systematic or improper practices issue, the Corrective Action plan could include a more in depth investigation and a possible suspension of an analytical method. In all cases, the actions taken are documented using the laboratory's Corrective Action system (refer to Section 12).

Due to the frequently unique nature of environmental samples, sometimes departures from documented policies and procedures are needed.

Note: The laboratory must implement Corrective Action procedures to resolve the deviation and limit qualification of the final results. The laboratory is not permitted to deviate from its VAP approved SOP if it intends to attest under affidavit that the "results" are VAP certified. When all Corrective Actions listed in the SOP have been exhausted, it may be necessary to use technical judgment in which case the decision process and rationale will be presented in the final report and/or affidavit and the data will be noted as 'not VAP certified' on the affidavit.

11.2 RESPONSIBILITIES AND AUTHORITIES

TestAmerica's Corporate SOP entitled Internal Investigation of Potential Data Discrepancies and Determination for Data Recall (CA-L-S-001) outlines the general procedures for the reporting and investigation of data discrepancies and alleged incidents of misconduct or violations of the TestAmerica's data integrity policies as well as the policies and procedures related to the determination of the potential need to recall data.

Under certain circumstances the Laboratory Director/Manager, Operations Manager, Project Manager, or a member of the QA team may exceptionally authorize departures from documented procedures or policies. The departures may be a result of procedural changes due to the nature of the sample; a one-time procedure for a client; QC failures with insufficient sample to reanalyze, etc. In most cases, the client must be informed of the departure prior to the reporting of the data. Any departures must be well documented using the laboratory's Corrective Action procedures described in Section 13. This information may also need to be documented in logbooks and/or data review as appropriate. Any impacted data must be referenced in a case narrative and/or flagged with an appropriate data qualifier.

Any misrepresentation or possible misrepresentation of analytical data discovered by any laboratory staff member must be reported to facility Senior Management within 24 hours. The Senior Management staff is comprised of the Laboratory Director, QA Manager, Customer

Service Manager, Operations Manager, I.T. Manager, H.R. Manager, and Technical Director. The reporting of issues involving alleged violations of the company's Data Integrity or Manual Integration procedures must be conveyed to an Ethics and Compliance Officer (ECO), Director of Quality and Client Advocacy, and the laboratory's Corporate Quality Director within 24 hours of discovery.

Whether an inaccurate result was reported due to calculation or quantitation errors, data entry errors, improper practices, or failure to follow SOPs, the data must be evaluated to determine the possible effect.

The Laboratory Director/Manager, QA Manager, ECOs, Corporate Quality Director, the COO, General Managers, and the Corporate Quality Directors have the authority and responsibility to halt work, withhold final reports, or suspend an analysis for due cause as well as authorize the resumption of work.

11.3 EVALUATION OF SIGNIFICANCE AND ACTIONS TAKEN

For each nonconforming issue reported, an evaluation of its significance and the level of management involvement needed is made. This includes reviewing its impact on the final data, whether or not it is an isolated or systematic issue, and how it relates to any special client requirements.

TestAmerica's Corporate Data Investigation and Recall Procedure (SOP CA-L-S-001) distinguishes between situations when it would be appropriate for laboratory management to make the decision on the need for client notification (written or verbal) and data recall (report revision) and when the decision must be made with the assistance of the ECOs and Corporate Management. Laboratory level decisions are documented and approved using the laboratory's standard nonconformance/Corrective Action reporting in lieu of the data recall determination form contained in TestAmerica Corporate SOP CA-L-S-001.

11.4 PREVENTION OF NONCONFORMING WORK

If it is determined that the nonconforming work could recur, further corrective actions must be made following the laboratory's Corrective Action system. On a monthly basis, the QA Department evaluates non-conformances to determine if any nonconforming work has been repeated multiple times. If so, the laboratory's Corrective Action process may be followed.

11.5 METHOD SUSPENSION/RESTRICTION (STOP WORK PROCEDURES)

In some cases it may be necessary to suspend/restrict the use of a method or target compound which constitutes significant risk and/or liability to the laboratory. Suspension/restriction procedures can be initiated by any of the persons noted in Section 11.2, Paragraph 5.

Prior to suspension/restriction, confidentiality must be respected, and the problem with the required corrective and preventive action must be stated in writing and presented to the Laboratory Director/Manager.

The Laboratory Director/Manager must arrange for the appropriate personnel to meet with the QA Manager as needed. This meeting must be held to confirm that there is a problem, that suspension/restriction of the method is required and must be concluded with a discussion of the steps necessary to bring the method/target or test fully back on line. In some cases that may not be necessary if all appropriate personnel have already agreed there is a problem and there is agreement on the steps needed to bring the method, target, or test fully back on line.

The QA Manager must also initiate a Corrective Action report as described in Section 12 if one has not already been started. A copy of any meeting notes and agreed-upon steps should be faxed or e-mailed by the laboratory to the appropriate General Manager and member of Corporate QA. This fax/e-mail acts as notification of the incident.

After suspension/restriction, the lab will hold all reports to clients pending review. No faxing, mailing or distributing through electronic means may occur. The report must not be posted for viewing on the Internet. It is the responsibility of the Laboratory Director/Manager to hold all reporting and to notify all relevant laboratory personnel regarding the suspension/restriction, i.e., Project Management, Log-in, etc. Clients must NOT generally be notified at this time. Analysis may proceed in some instances depending on the non-conformance issue.

Within 72 hours, the QA Manager must determine if compliance is now met and reports can be released, OR determine the plan of action to bring work into compliance, and release work. A team, with all principals involved (Laboratory Director, Technical Director, QA Manager, Group Leader) can devise a start-up plan to cover all steps from client notification through compliance and release of reports. Project Management, and the Directors of Client Services and Sales and Marketing must be notified if clients must be notified or if the suspension/restriction affects the laboratory's ability to accept work. The QA Manager must approve start-up or elimination of any restrictions after all corrective action is complete. This approval is given by final signature on the completed Corrective Action report.

SECTION 12

CORRECTIVE ACTION (NELAC 5.4.10)

12.1 OVERVIEW

A major component of TestAmerica's Quality Assurance (QA) Program is the problem investigation and feedback mechanism designed to keep the laboratory staff informed on quality related issues and to provide insight to problem resolution. When nonconforming work or departures from policies and procedures in the quality system or technical operations are identified, the Corrective Action procedure provides a systematic approach to assess the issues, restore the laboratory's system integrity, and prevent reoccurrence. Corrective actions are documented using Nonconformance Memos (NCM).

12.2 GENERAL

Problems within the quality system or within analytical operations may be discovered in a variety of ways, such as QC sample failures, internal or external audits, proficiency testing (PT) performance, client complaints, staff observation, etc.

The purpose of a Corrective Action system is to:

- Identify non-conformance events and assign responsibility(s) for investigating.
- Resolve non-conformance events and assign responsibility for any required corrective action.
- Identify systematic problems before they become serious.
- Identify and track client complaints and provide resolution (see more on client complaints in Section 11).

12.2.1 Non-Conformance Memo (NCM)

An NCM is used to document the following types of corrective actions:

- Deviations from an established procedure or SOP
- QC outside of limits (non matrix related)
- Isolated Reporting / Calculation Errors
- Client Complaints
- Discrepancies in materials / goods received vs. manufacturer packing slips

12.3 CLOSED LOOP CORRECTIVE ACTION PROCESS

Any employee in the company can initiate a Corrective Action. There are four main components to a closed-loop Corrective Action process once an issue has been identified--Cause Analysis, Selection and Implementation of Corrective Actions (both short and long term), Monitoring of the Corrective Actions, and Follow-up.

12.3.1 Cause Analysis

Upon discovery of a non-conformance event, the event must be defined and documented. An NCM must be initiated, someone is assigned to investigate the issue, and the event is investigated for cause. Table 12-1 provides some general guidelines on determining responsibility for assessment. SOP NC-QA-029, Nonconformance and Corrective Action System, establishes procedures for the identification and documentation of nonconformances and the corrective actions taken as a result of these events.

The cause analysis step is the key to the process as a long-term corrective action cannot be determined until the cause is determined.

If the cause is not readily obvious, the Group Leader, Lab Director, QA Manager, or designee is consulted.

12.3.2 Selection and Implementation of Corrective Actions

Where corrective action is needed, the laboratory must identify potential corrective actions. The action(s) most likely to eliminate the problem and prevent recurrence are selected and implemented. Responsibility for implementation is assigned.

Corrective actions must be, to a degree, appropriate to the magnitude of the problem identified through the cause analysis.

Whatever corrective action is determined to be appropriate, the laboratory must document and implement the changes. The NCM is used for this documentation.

12.3.3 Root Cause Analysis

Root Cause Analysis is a class of problem solving (investigative) methods aimed at identifying the basic or causal factor(s) that underlie variation in performance or the occurrence of a significant failure. The root cause may be buried under seemingly innocuous events, many steps preceding the perceived failure. At first glance, the immediate response is typically directed at a symptom and not the cause. Typically, root cause analysis would be best with three or more incidents to triangulate a weakness.

Systematically analyze and document the Root Causes of the more significant problems that are reported. Identify, track, and implement the corrective actions required to reduce the likelihood of recurrence of significant incidents. Trend the Root Cause data from these incidents to identify root causes that, when corrected, can lead to dramatic improvements in performance by eliminating entire classes of problems.

Identify the one event associated with problem and ask why this event occurred. Brainstorm the root causes of failures by asking why events occurred or conditions existed; and then why the cause occurred 5 consecutive times until you get to the root cause. For each of these sub events or causes, ask why it occurred. Repeat the process for the other events associated with the incident.

- Root cause analysis does not mean the investigation is over. Look at technique, or other systems outside the normal indicators. Often creative thinking will find root causes that ordinarily would be missed, and continue to plague the laboratory or operation.

12.3.4 Monitoring of the Corrective Actions

- The Department Manager/Group Leader and QA Manager is responsible to ensure the corrective action taken was effective.
- Ineffective actions are documented and re-evaluated until acceptable resolution is achieved. Department Managers are accountable to the Laboratory Director to ensure final acceptable resolution is achieved and documented appropriately.
- Each NCM is entered into a database for tracking purposes and a monthly summary of all corrective actions is printed out for review to aid in ensuring the corrective actions have taken effect.
- The QA Manager reviews monthly NCMs for trends. Highlights are included in the QA monthly report (refer to Section 16). If a significant trend develops that adversely affects quality, an audit of the area is performed and corrective action implemented.
- Any out-of-control situations that are not addressed acceptably at the laboratory level may be reported to the Corporate Quality Director by the QA Manager, indicating the nature of the out-of-control situation and problems encountered in solving the situation.

12.3.5 Follow-up Audits

- Follow-up audits may be initiated by the QA Manager and must be performed as soon as possible when the identification of a nonconformance casts doubt on the laboratory's compliance with its own policies and procedures, or on its compliance with state or federal requirements.
- These audits often follow the implementation of the corrective actions to verify effectiveness. An additional audit would only be necessary when a critical issue or risk to business is discovered.

Also refer to Section 15.2.4, Special Audits.)

12.4 TECHNICAL CORRECTIVE ACTIONS

In addition to providing acceptance criteria and specific protocols for technical corrective actions in the method SOPs, the laboratory has general procedures to be followed to determine when departures from the documented policies and procedures and quality control have occurred (refer to Section 11 for information regarding the control of non-conforming work). The documentation of these procedures is through the use of an NCM.

Table 12-1 includes examples of general technical corrective actions. For specific criteria and corrective actions, refer to the analytical methods or specific method SOPs.

Table 12-1 provides some general guidelines for identifying the individual(s) responsible for assessing each QC type and initiating corrective action. The table also provides general guidance on how a data set should be treated if associated QC measurements are unacceptable. Specific procedures are included in Method SOPs, Work Instructions, and QAM Sections 19 and 20. The QA Manager reviews all corrective actions monthly, at a minimum, and highlights are included in the QA monthly report.

To the extent possible, samples must be reported only if all quality control measures are acceptable. If the deficiency does not impair the usability of the results, data must be reported with an appropriate data qualifier and/or the deficiency must be noted in the case narrative. Where sample results may be impaired, the Project Manager is notified by a written NCM and appropriate corrective action (e.g., re-analysis) is taken and documented.

12.5 BASIC CORRECTIONS

When mistakes occur in records, each mistake must be crossed-out, and [not obliterated (e.g. no White-Out)], and the correct value entered alongside. All such corrections must be initialed (or signed) and dated by the person making the correction. In the case of records stored electronically, the original "uncorrected" file must be maintained intact and a second "corrected" file is created.

This same process applies to adding additional information to a record. All additions made later than the initial must also be initialed (or signed) and dated.

When corrections are due to reasons other than obvious transcription errors, the reason for the corrections (or additions) must also be documented.

**Table 12-1 .
General Corrective Action Procedures**

*** For the Ohio EPA Voluntary Action Program (VAP), please refer to the SOPs for the acceptable criteria, corrective actions, and exceptions.**

INORGANIC LABORATORY QUALITY CONTROL SAMPLES

Analysis	QC Sample	Method	NPDES ¹	Method	RCRA (SW846) ²
Alkalinity	* Method Blank	310.1 2320B	<u>Frequency:</u> 1 with each batch of samples processed not to exceed 20 samples <u>Criteria:</u> Concentration must be less than the reporting limit <u>Corrective Action:</u> Rerun all samples associated with unacceptable blank	—	N/A
	Laboratory Control Sample	310.1 2320B	<u>Frequency:</u> 1 with each batch of samples processed not to exceed 20 samples <u>Criteria:</u> Percent recovery must be within laboratory control limits <u>Corrective Action:</u> If not within laboratory control limits, rerun all associated samples	—	N/A
	Matrix Spike	310.1 2320B	<u>Total alkalinity:</u> 1 per batch of 20 samples	—	N/A
	Matrix Spike Duplicate	310.1 2320B	<u>Total alkalinity:</u> 1 per batch of 20 samples	—	N/A
	Duplicate	310.1 2320B	For carbonate, bicarbonate, hydroxide, alkalinity only. <u>Frequency:</u> 1 per batch of 10 samples <u>Criteria 310.1:</u> ≤ 20 % RPD ⁽³⁾ <u>Criteria 2320B:</u> ≤ 25 % RPD ⁽³⁾ <u>Corrective Action:</u> Flag data outside of limit.	—	N/A

INORGANIC LABORATORY QUALITY CONTROL SAMPLES (Cont'd)

Analysis	QC Sample	Method	NPDES ¹	Method	RCRA (SW846) ²
Ammonia	* Method Blank	350.1 350.2 SM4500 NH-E,F	<u>Frequency:</u> 1 with each batch of samples processed not to exceed 20 samples <u>Criteria:</u> Concentration less than reporting limit <u>Corrective Action:</u> Rerun all samples associated with unacceptable blank	—	N/A
	Laboratory Control Sample	350.1 350.2 SM4500 NH-E,F	<u>Frequency:</u> 1 with each batch of samples processed not to exceed 20 samples <u>Criteria:</u> Percent recovery must be within laboratory control limits <u>Corrective Action:</u> If not within control limits, rerun all associated samples	—	N/A
	Matrix Spike	350.1 350.2 SM4500 NH-E,F	<u>Frequency:</u> 1 per 20 samples, minimum of one per batch of samples processed <u>Criteria:</u> Percent recovery must be within laboratory control limits <u>Corrective Action:</u> Flag data outside of limit	—	N/A

INORGANIC LABORATORY QUALITY CONTROL SAMPLES (Cont'd)

Analysis	QC Sample	Method	NPDES ¹	Method	RCRA (SW846) ²
Ammonia (Cont'd)	Matrix Spike Duplicate	350.1 350.2 SM4500 NH-E,F	<u>Frequency:</u> 1 per 20 samples, minimum of one per batch of samples processed <u>Criteria:</u> Percent recovery must be within laboratory control limits <u>Corrective Action:</u> Flag data outside of limit	—	N/A
	Duplicate	350.1 350.2 SM4500 NH-E,F	N/A	—	N/A
Ammonia (TKN)	* Method Blank	351.2 351.3 SM4500 NO ₃	<u>Frequency:</u> 1 with each batch of samples processed not to exceed 20 samples <u>Criteria:</u> Concentration must be less than the reporting limit <u>Corrective Action:</u> Rerun all samples associated with unacceptable blank	—	N/A

INORGANIC LABORATORY QUALITY CONTROL SAMPLES (Cont'd)

Analysis	QC Sample	Method	NPDES ¹	Method	RCRA (SW846) ²
Ammonia (TKN) (Cont'd)	Laboratory Control Sample	351.2 351.3 SM4500 NO ₃	<u>Frequency:</u> 1 with each batch of samples processed not to exceed 20 samples <u>Criteria:</u> Percent recovery must be within laboratory control limits <u>Corrective Action:</u> If not within laboratory control limits, rerun all associated samples	—	N/A
	Matrix Spike	351.2 351.3 SM4500 NO ₃	<u>Frequency:</u> 1 per 20 samples, minimum of one per batch of samples processed <u>Criteria:</u> Must be within laboratory control limits <u>Corrective Action:</u> Flag data outside of limit	—	N/A
	Matrix Spike Duplicate	351.2 351.3 SM4500 NO ₃	<u>Frequency:</u> 1 per 20 samples, minimum of one per batch of samples processed <u>Criteria:</u> Must be within laboratory control limits <u>Corrective Action:</u> Flag data outside of limit	—	N/A
	Duplicate	351.2 351.3 SM4500 NO ₃	N/A	—	N/A

INORGANIC LABORATORY QUALITY CONTROL SAMPLES (Cont'd)

Analysis	QC Sample	Method	NPDES ¹	Method	RCRA (SW846) ²
BOD	* Method Blank	405.1 SM5210B	<u>Frequency:</u> 1 with each batch of samples processed not to exceed 20 samples <u>Criteria:</u> Concentration must be less than the reporting limit <u>Corrective Action:</u> Rerun all samples associated with unacceptable blank	—	N/A
	Laboratory Control Sample and Laboratory Control Sample Duplicate	405.1 SM5210B	<u>Frequency:</u> 1 with each batch of samples processed not to exceed 20 samples <u>Criteria:</u> Percent recovery must be within laboratory control limits <u>Corrective Action:</u> If not within laboratory control limits, rerun all associated samples	—	N/A
	Matrix Spike	405.1 SM5210B	N/A	—	N/A
	Matrix Spike Duplicate	405.1 SM5210B	N/A	—	N/A
	Duplicate	405.1 SM5210B	N/A	—	N/A

INORGANIC LABORATORY QUALITY CONTROL SAMPLES (Cont'd)

Analysis	QC Sample	Method	NPDES ¹	Method	RCRA (SW846) ²
Bromide	* Method Blank	300.0A ⁽⁵⁾	<u>Frequency:</u> 1 with each batch of samples processed not to exceed 20 samples <u>Criteria:</u> Concentration must be less than the reporting limit <u>Corrective Action:</u> Rerun all samples associated with unacceptable blank	9056A	<u>Frequency:</u> 1 with each batch of samples processed not to exceed 20 samples <u>Criteria:</u> Concentration must be less than the reporting limit <u>Corrective Action:</u> Rerun all samples associated with unacceptable blank
	Laboratory Control Sample and Laboratory Control Sample Duplicate	300.0A ⁽⁵⁾	<u>Frequency:</u> 1 with each batch of samples processed not to exceed 20 samples <u>Criteria:</u> Percent recovery must be within laboratory control limits <u>Corrective Action:</u> If not within control limits, rerun all associated samples	9056A	<u>Frequency:</u> 1 with each batch of samples processed not to exceed 20 samples <u>Criteria:</u> Percent recovery must be within laboratory control limits <u>Corrective Action:</u> If not within control limits, rerun all associated samples
	Matrix Spike	300.0A ⁽⁵⁾	<u>Frequency:</u> 1 per 10 samples, minimum of one per batch of samples processed <u>Criteria:</u> Percent recovery must be within laboratory control limits <u>Corrective Action:</u> Flag data outside of limit	9056A	<u>Frequency:</u> 1 with each batch of samples processed not to exceed 20 samples <u>Criteria:</u> Percent recovery must be within laboratory control limits <u>Corrective Action:</u> Flag data associated with MS outside of limit
	Matrix Spike Duplicate	300.0A ⁽⁵⁾	N/A	9056A	N/A
	Duplicate	300.0A ⁽⁵⁾	N/A	9056A	N/A

INORGANIC LABORATORY QUALITY CONTROL SAMPLES (Cont'd)

Analysis	QC Sample	Method	NPDES ¹	Method	RCRA (SW846) ²
Chemical Oxygen Demand (COD)	* Method Blank	410.4 SM5220D	<u>Frequency</u> : 1 with each batch of samples processed not to exceed 20 samples <u>Criteria</u> : Concentration must be less than the reporting limit <u>Corrective Action</u> : Rerun all samples associated with unacceptable blank	—	N/A
	Laboratory Control Sample and Laboratory Control Sample Duplicate	410.4 SM5220D	<u>Frequency</u> : 1 with each batch of samples processed not to exceed 20 samples <u>Criteria</u> : Percent recovery must be within laboratory control limits <u>Corrective Action</u> : If not within laboratory control limits, rerun all associated samples	—	N/A
	Matrix Spike	410.4 SM5220D	<u>Frequency</u> : 1 per 10 samples, minimum of one per batch of samples processed <u>Criteria</u> : Must be within laboratory control limits <u>Corrective Action</u> : Flag data outside of limit	—	N/A
	Matrix Spike Duplicate	410.4 SM5220D	<u>Frequency</u> : 1 per 20 samples, minimum of one per batch of samples processed <u>Criteria</u> : Must be within laboratory control limits <u>Corrective Action</u> : Flag data outside of limit	—	N/A
	Duplicate	410.4 SM5220D	N/A	—	N/A

INORGANIC LABORATORY QUALITY CONTROL SAMPLES (Cont'd)

Analysis	QC Sample	Method	NPDES ¹	Method	RCRA (SW846) ²
Chloride	* Method Blank	300.0A ⁵ 325.2 325.3	<u>Frequency:</u> 1 with each batch of samples processed not to exceed 20 samples <u>Criteria:</u> Concentration must be less than the reporting limit <u>Corrective Action:</u> Rerun all samples associated with unacceptable blank	9056A	<u>Frequency:</u> 1 with each batch of samples processed not to exceed 20 samples <u>Criteria:</u> Concentration must be less than the reporting limit <u>Corrective Action:</u> Rerun all samples associated with unacceptable blank
	Laboratory Control Sample	300.0A ⁵ 325.2 325.3	<u>Frequency:</u> 1 with each batch of samples processed not to exceed 20 samples <u>Criteria:</u> Percent recovery must be within laboratory control limits <u>Corrective Action:</u> If not within control limits, rerun all associated samples	9056A	<u>Frequency:</u> 1 with each batch of samples processed not to exceed 20 samples <u>Criteria:</u> Percent recovery must be within laboratory control limits <u>Corrective Action:</u> If not within laboratory control limits, rerun all associated samples
	Matrix Spike	300.0A ⁽⁵⁾	<u>Frequency:</u> 1 per 10 samples, minimum of one per batch of samples processed <u>Criteria:</u> Percent recovery must be within laboratory control limits <u>Corrective Action:</u> Flag data outside of limit	9056A	<u>Frequency:</u> 1 with each batch of samples processed not to exceed 20 samples <u>Criteria:</u> Percent recovery must be within laboratory control limits <u>Methods 9251 Corrective Action:</u> If not within laboratory control limits, rerun all associated samples <u>Method 9056/9253</u> <u>Corrective Action:</u> Flag data associated with MS outside of limits

INORGANIC LABORATORY QUALITY CONTROL SAMPLES (Cont'd)

Analysis	QC Sample	Method	NPDES ¹	Method	RCRA (SW846) ²
Chloride (cont'd)	Matrix Spike Duplicate	325.2 325.3	<u>Frequency:</u> 1 per 20 samples, minimum of one per batch of samples processed <u>Criteria:</u> Percent recovery must be within laboratory control limits <u>Corrective Action:</u> Flag data outside of limit	9056A	<u>Frequency:</u> 1 with each batch of samples processed not to exceed 20 samples <u>Criteria:</u> Percent recovery must be within laboratory control limits/< 20 % RPD ⁽³⁾ <u>Corrective Action:</u> Flag data outside of limit <u>Method 9056:</u> MSD is not applicable
	Duplicate	300.0A ⁽⁵⁾ 325.2 325.3	N/A	9056A	N/A
Chlorine, Residual	* Method Blank	330.5	<u>Frequency:</u> 1 with each batch of samples processed not to exceed 20 samples <u>Criteria:</u> Concentration must be less than the reporting limit <u>Corrective Action:</u> Rerun all samples associated with unacceptable blank	—	N/A
	Laboratory Control Sample	330.5	N/A	—	N/A
	Matrix Spike	330.5	N/A	—	N/A
	Matrix Spike Duplicate	330.5	N/A	—	N/A
	Duplicate	330.5	<u>Frequency:</u> 1 with each batch of samples processed not to exceed 20 samples <u>Criteria:</u> ≤ 20 % RPD ⁽³⁾ <u>Corrective Action:</u> Flag data outside of limit.	—	Water

INORGANIC LABORATORY QUALITY CONTROL SAMPLES (Cont'd)

Analysis	QC Sample	Method	NPDES ¹	Method	RCRA (SW846) ²
Chromium (Cr ⁺⁶)	* Method Blank	3500 Cr-D	<u>Frequency:</u> 1 with each batch of samples processed not to exceed 20 samples <u>Criteria:</u> Concentration must be less than the reporting limit <u>Corrective Action:</u> Rerun all samples associated with unacceptable blank unless the blank is above RL, and samples are ND.	7196A 3060A	<u>Frequency:</u> 1 with each batch of samples processed not to exceed 20 samples <u>Criteria:</u> Concentration less than reporting limit <u>Corrective Action:</u> Rerun all samples associated with unacceptable blank unless the blank is above RL, and samples are ND.
	Laboratory Control Sample	3500 Cr-D	<u>Frequency:</u> 1 with each batch of samples processed not to exceed 20 samples <u>Criteria:</u> Percent recovery must be within laboratory control limits <u>Corrective Action:</u> If not within laboratory control limits, rerun all associated samples	7196A 3060A	<u>Frequency:</u> 1 with each batch of samples processed not to exceed 20 samples prepped <u>Criteria:</u> percent recovery for water must be within $\pm 15\%$ and for solids must be within $\pm 20\%$ <u>Corrective Action:</u> Rerun all samples associated with unacceptable LCS
	Matrix Spike	3500 Cr-D	<u>Frequency:</u> 1 with each batch of samples processed not to exceed 20 samples <u>Criteria:</u> Must be within laboratory QC limits <u>Corrective Action:</u> Flag data outside of limit	3060A 7196A	<u>Frequency:</u> 1 with each batch of samples processed not to exceed 20 samples <u>Criteria:</u> Advisory limits are 75% - 125% recovery <u>Corrective Action:</u> Flag data associated with unacceptable Matrix Spike

INORGANIC LABORATORY QUALITY CONTROL SAMPLES (Cont'd)

Analysis	QC Sample	Method	NPDES ¹	Method	RCRA (SW846) ²
Chromium (Cr ⁺⁶) (Cont'd)	Matrix Spike Duplicate	3500 Cr-D	<u>Frequency:</u> 1 with each batch of samples processed not to exceed 20 samples <u>Criteria:</u> Must be within laboratory QC limits <u>Corrective Action:</u> Flag data outside of limit	7196A 3060A	<u>Frequency:</u> 1 with each batch of samples processed not to exceed 20 samples <u>Criteria:</u> Advisory limits are 75% - 125% recovery <u>Corrective Action:</u> Flag data associated with unacceptable Matrix Spike
	Duplicate	3500 Cr-D	N/A	7196A 3060A	<u>Frequency:</u> 1 with each batch of samples processed not to exceed 20 samples <u>Criteria:</u> ≤ 20 % RPD ⁽³⁾ limit <u>Corrective Action:</u> Flag data outside of limit.

INORGANIC LABORATORY QUALITY CONTROL SAMPLES (Cont'd)

Analysis	QC Sample	Method	NPDES ¹	Method	RCRA (SW846) ²
Conductivity, Specific	* Method Blank	120.1 SM2510B	N/A	9050A	Not Applicable
	Laboratory Control Sample	120.1 SM2510B	<u>Frequency:</u> 1 with each batch of samples processed not to exceed 20 samples <u>Criteria:</u> Percent recovery must be within laboratory control limits <u>Corrective Action:</u> If not within laboratory control limits, rerun all associated samples	9050A	<u>Frequency:</u> 1 with each batch of samples processed not to exceed 20 samples <u>Criteria:</u> Percent recovery must be within laboratory control limits <u>Corrective Action:</u> If not within laboratory control limits, rerun all associated samples
	Matrix Spike	120.1 SM2510B	N/A	9050A	N/A
	Matrix Spike Duplicate	120.1 SM2510B	N/A	9050A	N/A
	Duplicate	120.1 SM2510B	<u>Frequency:</u> 1 with each batch of samples processed not to exceed 10 samples <u>Criteria:</u> $\leq 20\%$ RPD ⁽³⁾ <u>Corrective Action:</u> Flag data outside of limit.	9050A	<u>Frequency:</u> 1 with each batch of samples processed not to exceed 10 samples

INORGANIC LABORATORY QUALITY CONTROL SAMPLES (Cont'd)

Analysis	QC Sample	Method	NPDES ¹	Method	RCRA (SW846) ²
Cyanide (Amenable)	* Method Blank	335.1 SM4500C N-G	<u>Frequency:</u> 1 with each batch of samples processed not to exceed 20 samples <u>Criteria:</u> Concentration must be less than the reporting limit <u>Corrective Action:</u> Rerun all samples associated with unacceptable blank	9012A	<u>Frequency:</u> 1 with each batch of samples processed not to exceed 20 samples <u>Criteria:</u> Concentration less than reporting limit <u>Corrective Action:</u> Rerun all samples associated with unacceptable blank
	Laboratory Control Sample	335.1 SM4500C N-G	<u>Frequency:</u> 1 with each batch of samples processed not to exceed 20 samples <u>Criteria:</u> Percent recovery must be within laboratory control limits <u>Corrective Action:</u> If not within laboratory control limits, rerun all associated samples	9012A	<u>Frequency:</u> 1 with each batch of samples processed not to exceed 20 samples <u>Criteria:</u> Percent recovery must be within laboratory control limits <u>Corrective Action:</u> Rerun all samples associated with unacceptable LCS
	Matrix Spike	335.1 SM4500C N-G	N/A	9012A	N/A
	Matrix Spike Duplicate	335.1 SM4500C N-G	N/A	9012A	<u>Frequency:</u> 1 with each batch of samples processed not to exceed 20 samples <u>Criteria:</u> Percent recovery must be within lab control limits <u>Corrective Action:</u> Flag data associated with unacceptable Matrix Spike
	Duplicate	335.1 SM4500C N-G	N/A	9012A	N/A

INORGANIC LABORATORY QUALITY CONTROL SAMPLES (Cont'd)

Analysis	QC Sample	Method	NPDES ¹	Method	RCRA (SW846) ²
Cyanide (Total)	* Method Blank	335.2 335.3 335.4 4500-CN E 335.2-CLP-M	<u>Frequency:</u> 1 with each batch of samples processed not to exceed 20 samples <u>Criteria:</u> Concentration must be less than the reporting limit <u>Corrective Action:</u> Rerun all samples associated with unacceptable blank unless the blank is above RL, and samples are ND.	9012A	<u>Frequency:</u> 1 with each batch of samples processed not to exceed 20 samples <u>Criteria:</u> Concentration less than reporting limit <u>Corrective Action:</u> Rerun all samples associated with unacceptable blank unless the blank is above RL, and samples are ND.
	Laboratory Control Sample	335.2 335.3 335.4 4500-CN E 335.2-CLP-M	<u>Frequency:</u> 1 with each batch of samples processed not to exceed 20 samples <u>Criteria:</u> Percent recovery must be within laboratory control limits <u>Corrective Action:</u> If not within laboratory control limits, rerun all associated samples	9012A	<u>Frequency:</u> 1 with each batch of samples processed not to exceed 20 samples <u>Criteria:</u> Percent recovery must be within laboratory control limits <u>Corrective Action:</u> Rerun all samples associated with unacceptable LCS
	Matrix Spike	335.2 335.3 335.4 4500-CN E 335.2-CLP-M	<u>Frequency:</u> 1 per 20 samples, minimum of one per batch of samples processed <u>Criteria:</u> Percent recovery must be within laboratory control limits <u>Corrective Action:</u> Flag data outside of limit	9012A	<u>Frequency:</u> 1 with each batch of samples processed not to exceed 20 samples <u>Criteria:</u> Percent recovery must be within laboratory control limits <u>Corrective Action:</u> Flag data associated with unacceptable Matrix Spike

INORGANIC LABORATORY QUALITY CONTROL SAMPLES (Cont'd)

Analysis	QC Sample	Method	NPDES ¹	Method	RCRA (SW846) ²
Cyanide (Total) (cont'd)	Matrix Spike Duplicate	335.2 335.3 335.4 4500-CN E 335.2-CLP-M	Frequency: 1 per 20 samples, minimum of one per batch of samples processed Criteria: Percent recovery must be within laboratory control limits Corrective Action: Flag data outside of limit	9012A	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Percent recovery must be within laboratory control limits Corrective Action: Flag data associated with unacceptable Matrix Spike
	Duplicate	335.2 335.3 335.4 335.2-CLP-M	N/A	9012A	N/A
Flashpoint	* Method Blank	—	N/A	1010 ASTM D93-9	N/A
	Laboratory Control Sample	—	N/A	1010 ASTM D93-9	N/A
	Matrix Spike	—	N/A	1010 ASTM D93-9	N/A
	Matrix Spike Duplicate	—	N/A	1010 ASTM D93-9	N/A
	Duplicate	—	Frequency: 1 per batch of ≤20 samples per matrix Criteria: RPD ⁽³⁾ must be ≤ 20% Corrective Action: Flag data associated with unacceptable Duplicate	1010 ASTM D93-9	Frequency: 1 per batch of ≤20 samples per matrix Criteria: RPD ⁽³⁾ must be ≤ 20% Corrective Action: Flag data associated with unacceptable Duplicate

INORGANIC LABORATORY QUALITY CONTROL SAMPLES (Cont'd)

Analysis	QC Sample	Method	NPDES ¹	Method	RCRA (SW846) ²
Fluoride	* Method Blank	300.0A ⁽⁵⁾ 340.2 SM4500F-C,ISE	<u>Frequency:</u> 1 with each batch of samples processed not to exceed 20 samples <u>Criteria:</u> Concentration must be less than the reporting limit <u>Corrective Action:</u> Rerun all samples associated with unacceptable blank	9056A	<u>Frequency:</u> 1 with each batch of samples processed not to exceed 20 samples <u>Criteria:</u> Concentration must be less than the reporting limit <u>Corrective Action:</u> Rerun all samples associated with unacceptable
	Laboratory Control Sample	300.0A ⁽⁵⁾ 340.2 SM4500F-C,ISE	<u>Frequency:</u> 1 with each batch of samples processed not to exceed 20 samples <u>Criteria:</u> Percent recovery must be within laboratory control limits <u>Corrective Action:</u> If not within laboratory control limits, rerun all associated samples	9056A	<u>Frequency:</u> 1 with each batch of samples processed not to exceed 20 samples <u>Criteria:</u> Percent recovery must be within laboratory control limits <u>Corrective Action:</u> If not within control limits, rerun all associated samples
	Laboratory Control Sample Duplicate	300.0A ⁽⁵⁾ SM4500F-C,ISE	<u>Frequency:</u> 1 with each batch of samples processed not to exceed 20 samples <u>Criteria:</u> Percent recovery must be within laboratory control limits <u>Corrective Action:</u> If not within laboratory control limits, rerun all associated samples	9056	<u>Frequency:</u> 1 with each batch of samples processed not to exceed 20 samples <u>Criteria:</u> Percent recovery must be within laboratory control limits <u>Corrective Action:</u> If not within control limits, rerun all associated samples

INORGANIC LABORATORY QUALITY CONTROL SAMPLES (Cont'd)

Analysis	QC Sample	Method	NPDES ¹	Method	RCRA (SW846) ²
Flouride (Cont'd)	Matrix Spike	300.0A ⁽⁵⁾ 340.2 SM4500F- C,ISE	<u>Frequency</u> : 1 per 10 samples by IC <u>Criteria</u> : Must be within laboratory QC limits <u>Corrective Action</u> : Flag data outside of limit	9056A	<u>Frequency</u> : 1 with each batch of samples processed not to exceed 20 samples <u>Criteria</u> : Percent recovery must be within laboratory control limits <u>Corrective Action</u> : Flag data associated with outside of limit
	Matrix Spike Duplicate	340.2 SM4500F- C,ISE	<u>Frequency</u> : 1 per 20 samples by IC <u>Criteria</u> : Must be within laboratory QC limits <u>Corrective Action</u> : Flag data outside of limit	340.2	N/A
	Duplicate	300.0A ⁽⁵⁾ 340.2 SM4500F- C,ISE	N/A	9056A	<u>Frequency</u> : 1 with each batch of samples processed <u>Criteria</u> : RPD ⁽³⁾ must be within laboratory control limits <u>Corrective Action</u> : Flag data associated with duplicates outside of laboratory RPD ⁽³⁾ limits

INORGANIC LABORATORY QUALITY CONTROL SAMPLES (Cont'd)

Analysis	QC Sample	Method	NPDES ¹	Method	RCRA (SW846) ²
Hardness	* Method Blank	130.2 2340B	<u>Frequency:</u> 1 with each batch of samples processed not to exceed 20 samples <u>Criteria:</u> Concentration must be less than the reporting limit <u>Corrective Action:</u> Rerun all samples associated with unacceptable blank	—	N/A
	Laboratory Control Sample	130.2 2340B	<u>Frequency:</u> 1 with each batch of samples processed not to exceed 20 samples <u>Criteria:</u> Percent recovery must be within laboratory control limits <u>Corrective Action:</u> If not within laboratory control limits, rerun all associated samples	—	N/A
	Matrix Spike	130.2 2340B	<u>Method 130.2:</u> 1 per 20 samples <u>Method 2340B:</u> <u>Frequency , Criteria, and Corrective Action:</u> See ICP Metals Method 200.7 Requirements	—	N/A

INORGANIC LABORATORY QUALITY CONTROL SAMPLES (Cont'd)

Analysis	QC Sample	Method	NPDES ¹	Method	RCRA (SW846) ²
Hardness (cont'd)	Matrix Spike Duplicate	130.2 2340B	<u>Method 130.2:</u> 1 per 20 samples <u>Method 2340B:</u> <u>Frequency, Criteria, and Corrective Action:</u> See ICP Metals Method 200.7 Requirements	—	N/A
	Duplicate	130.2 2340B	N/A	—	N/A
Iron, Ferrous & Ferric	* Method Blank	3500-Fe D	<u>Frequency:</u> 1 with each batch of samples processed not to exceed 20 samples <u>Criteria:</u> Concentration must be less than the reporting limit <u>Corrective Action:</u> Rerun all samples associated with unacceptable blank	—	N/A
	Laboratory Control Sample	3500-Fe D	<u>Frequency:</u> 1 with each batch of samples processed not to exceed 20 samples <u>Criteria:</u> Percent recovery must be within laboratory control limits <u>Corrective Action:</u> If not within laboratory control limits, rerun all associated samples	—	N/A

INORGANIC LABORATORY QUALITY CONTROL SAMPLES (Cont'd)

Analysis	QC Sample	Method	NPDES ¹	Method	RCRA (SW846) ²
Iron, Ferrous & Ferric (Cont'd)	Matrix Spike	3500-Fe D	<u>Frequency:</u> 1 every 10 samples <u>Criteria:</u> Must be within laboratory QC limits <u>Corrective Action:</u> Flag associated data outside of limit	—	N/A
	Matrix Spike Duplicate	3500-Fe D	<u>Frequency:</u> 1 every 10 samples <u>Criteria:</u> Must be within laboratory QC limits <u>Corrective Action:</u> Flag associated data outside of limit	—	N/A
	Duplicate	3500-Fe D	N/A	—	N/A
Nitrate	* Method Blank	300.0A ⁽⁵⁾ 353.2 SM4500-NO ₃ -E	<u>Frequency:</u> 1 with each batch of samples processed not to exceed 20 samples <u>Criteria:</u> Concentration must be less than the reporting limit <u>Corrective Action:</u> Rerun all samples associated with unacceptable blank	9056A	<u>Frequency:</u> 1 with each batch of samples processed not to exceed 20 samples <u>Criteria:</u> Concentration must be less than the reporting limit

INORGANIC LABORATORY QUALITY CONTROL SAMPLES (Cont'd)

Analysis	QC Sample	Method	NPDES ¹	Method	RCRA (SW846) ²
Nitrate (Cont'd)	Laboratory Control Sample	300.0A ⁽⁵⁾ 353.2 SM4500- NO ₃ -E	Frequency: 1 with each batch of samples processed not to exceed 20 samples <u>Criteria:</u> Percent recovery must be within laboratory control limits <u>Corrective Action:</u> If not within laboratory control limits, rerun all associated samples	9056A	Frequency: 1 with each batch of samples processed not to exceed 20 samples <u>Criteria:</u> Percent recovery must be within laboratory control limits <u>Corrective Action:</u> If not within laboratory control limits, rerun all associated samples
	Matrix Spike	300.0A ⁽⁵⁾ 353.2 SM4500- NO ₃ -E	Frequency: 1 per 10 samples, minimum of one per batch of samples processed <u>Criteria:</u> Must be within laboratory control limits <u>Corrective Action:</u> Flag data outside of limit	9056A	Frequency: 1 with each batch of samples processed not to exceed 20 samples <u>Criteria:</u> Percent recovery must be within laboratory control limits <u>Corrective Action:</u> If not within laboratory control limits, flag all associated samples
	Matrix Spike Duplicate	300.0A ⁽⁵⁾ 353.2 SM4500- NO ₃ -E	Frequency: 1 per 20 samples, minimum of one per batch of samples processed <u>Criteria:</u> Must be within laboratory control limits <u>Corrective Action:</u> Flag data outside of limit	9056A	N/A

INORGANIC LABORATORY QUALITY CONTROL SAMPLES (Cont'd)

Analysis	QC Sample	Method	NPDES ¹	Method	RCRA (SW846) ²
Nitrate (cont'd)	Duplicate	300.0A ⁽⁵⁾ 353.2 SM4500- NO ₃ -E	N/A	9056A	<u>Frequency:</u> 1 per 10 samples <u>Criteria:</u> RPD ⁽³⁾ must be within laboratory control limits <u>Corrective Action:</u> If not within laboratory control limits, flag all associated samples
Nitrite	* Method Blank	300.0A ⁽⁵⁾ 353.2	<u>Frequency:</u> 1 with each batch of samples processed not to exceed 20 samples <u>Criteria:</u> Concentration must be less than the reporting limit <u>Corrective Action:</u> Rerun all samples associated with unacceptable blank	9056A	<u>Frequency:</u> 1 with each batch of samples processed not to exceed 20 samples <u>Criteria:</u> Concentration must be less than the reporting limit <u>Corrective Action:</u> Rerun all samples associated with unacceptable blank
	Laboratory Control Sample	300.0A ⁽⁵⁾ 354.1 353.2	<u>Frequency:</u> 1 with each batch of samples processed not to exceed 20 samples <u>Criteria:</u> Percent recovery must be within laboratory control limits <u>Corrective Action:</u> If not within laboratory control limits, rerun all associated samples	9056A	<u>Frequency:</u> 1 with each batch of samples processed not to exceed 20 samples <u>Criteria:</u> Percent recovery must be within laboratory control limits <u>Corrective Action:</u> If not within laboratory control limits, rerun all associated samples

INORGANIC LABORATORY QUALITY CONTROL SAMPLES (Cont'd)

Analysis	QC Sample	Method	NPDES ¹	Method	RCRA (SW846) ²
Nitrite (Cont'd)	Matrix Spike	300.0A ⁽⁵⁾ 354.1 353.2	<u>Frequency:</u> 1 per 10 samples, minimum of one per batch of samples processed <u>Criteria:</u> Must be within laboratory control limits <u>Corrective Action:</u> Flag data outside of limit	9056A	<u>Frequency:</u> 1 with each batch of samples processed not to exceed 20 samples <u>Criteria:</u> Percent recovery must be within laboratory control limits <u>Corrective Action:</u> If not within laboratory control limits, flag all associated samples
	Matrix Spike Duplicate	300.0A ⁽⁵⁾ 354.1 353.2	<u>Frequency:</u> 1 per 20 samples, minimum of one per batch of samples processed <u>Criteria:</u> Must be within laboratory control limits <u>Corrective Action:</u> Flag data outside of limit	9056A	N/A
	Duplicate	300.0A ⁽⁵⁾ 354.1 353.2	N/A	9056A	<u>Frequency:</u> 1 per 10 samples <u>Criteria:</u> RPD ⁽³⁾ must be within laboratory control limits <u>Corrective Action:</u> If not within laboratory control limits, flag all associated samples

INORGANIC LABORATORY QUALITY CONTROL SAMPLES (Cont'd)

Analysis	QC Sample	Method	NPDES ¹	Method	RCRA (SW846) ²
Nitrate-Nitrite	* Method Blank	353.2	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Concentration must be less than the reporting limit Corrective Action: Rerun all samples associated with unacceptable blank	—	N/A
	Laboratory Control Sample	353.2	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Percent recovery must be within laboratory control limits Corrective Action: If not within laboratory control limits, rerun all associated samples	—	N/A
	Matrix Spike	353.2	Frequency: 1 per 20 samples, minimum of one per batch of samples processed Criteria: Percent recovery must be within laboratory control limits Corrective Action: Flag data outside of limit	—	N/A
	Matrix Spike Duplicate	353.2	Frequency: 1 per 20 samples, minimum of one per batch of samples processed Criteria: Percent recovery must be within laboratory control limits Corrective Action: Flag data outside of limit	—	N/A
	Duplicate	353.2	N/A	—	N/A

INORGANIC LABORATORY QUALITY CONTROL SAMPLES (Cont'd)

Analysis	QC Sample	Method	NPDES ¹	Method	RCRA (SW846) ²
pH	* Method Blank	150.1 SM4500H-B	N/A	9040B 9045C	N/A
	Laboratory Control Sample	150.1 SM4500H-B	<u>Frequency:</u> 1 with each batch of samples processed not to exceed 20 samples <u>Criteria:</u> Percent recovery must be within laboratory control limits <u>Corrective Action:</u> If not within laboratory control limits, rerun all associated samples	9040B 9045C	N/A
	Matrix Spike	150.1 SM4500H-B	N/A	9040B 9045C	N/A
	Matrix Spike Duplicate	150.1 SM4500H-B	N/A	9040B 9045C	N/A
	Duplicate	150.1 SM4500H-B	<u>Frequency:</u> 1 with each batch of samples processed not to exceed 10 samples per matrix <u>Criteria:</u> ≤ 20 % RPD ⁽³⁾ limit <u>Corrective Action:</u> Flag data outside of limit.	9040B 9045C	<u>Frequency:</u> 1 with each batch of samples processed not to exceed 20 samples <u>Criteria:</u> Advisory limits are ≤ 20% RPD ⁽³⁾ <u>Corrective Action:</u> Flag data associated with unacceptable Duplicate
Phenolics	* Method Blank	420.1	<u>Frequency:</u> 1 with each batch of samples processed not to exceed 20 samples <u>Criteria:</u> Concentration must be less than the reporting limit <u>Corrective Action:</u> Rerun all samples associated with unacceptable blank	9065	<u>Frequency:</u> 1 with each batch of samples processed not to exceed 20 samples <u>Criteria:</u> Concentration less than reporting limit <u>Corrective Action:</u> Rerun all samples associated with unacceptable blank

INORGANIC LABORATORY QUALITY CONTROL SAMPLES (Cont'd)

Analysis	QC Sample	Method	NPDES ¹	Method	RCRA (SW846) ²
Phenolics (Cont'd)	Laboratory Control Sample	420.1	<u>Frequency:</u> 1 with each batch of samples processed not to exceed 20 samples <u>Criteria:</u> Percent recovery must be within laboratory control limits <u>Corrective Action:</u> If not within laboratory control limits, rerun all associated samples	9065	<u>Frequency:</u> 1 with each batch of samples processed not to exceed 20 samples <u>Criteria:</u> Percent recovery must be within laboratory control limits <u>Corrective Action:</u> If not within laboratory control limits, rerun all associated samples
	Matrix Spike	420.1	<u>Frequency:</u> 1 with each batch of samples processed not to exceed 20 samples <u>Criteria:</u> Percent recovery must be within laboratory control limits <u>Corrective Action:</u> Flag data associated with unacceptable matrix spike	9065	<u>Frequency:</u> 1 with each batch of samples processed not to exceed 20 samples <u>Criteria:</u> Percent recovery must be within laboratory control limits <u>Corrective Action:</u> Flag associated data
	Matrix Spike Duplicate	420.1	<u>Frequency:</u> 1 with each batch of samples processed not to exceed 20 samples <u>Criteria:</u> Percent recovery must be within laboratory control limits <u>Corrective Action:</u> Flag associated data	9065	<u>Frequency:</u> 1 with each batch of samples processed not to exceed 20 samples <u>Criteria:</u> Percent recovery must be within laboratory control limits <u>Corrective Action:</u> Flag associated data

INORGANIC LABORATORY QUALITY CONTROL SAMPLES (Cont'd)

Analysis	QC Sample	Method	NPDES ¹	Method	RCRA (SW846) ²
Phosphorus (Total and Ortho-phosphate)	* Method Blank	300.0 ^(4,5) 365.3 365.1 SM4500P-E	<u>Frequency</u> : 1 with each batch of samples processed not to exceed 20 samples <u>Criteria</u> : Concentration must be less than the reporting limit <u>Corrective Action</u> : Rerun all samples associated with unacceptable blank	9056A	<u>Frequency</u> : 1 with each batch of samples processed not to exceed 20 samples <u>Criteria</u> : Concentration less than reporting limit <u>Corrective Action</u> : Rerun all samples associated with unacceptable blank
	Laboratory Control Sample	300.0 ^(4,5) 365.3 365.1 SM4500P-E	<u>Frequency</u> : 1 with each batch of samples processed not to exceed 20 samples <u>Criteria</u> : Percent recovery must be within laboratory control limits <u>Corrective Action</u> : If not within laboratory control limits, rerun all associated samples	9056A	<u>Frequency</u> : 1 with each batch of samples processed not to exceed 20 samples <u>Criteria</u> : Percent recovery must be within laboratory control limits <u>Corrective Action</u> : If not within laboratory control limits, rerun all associated samples
	Matrix Spike	300.0 ^(4,5) 365.3 365.1 SM4500P-E	<u>Frequency</u> : 1 per 10 samples <u>Criteria</u> : Must be within laboratory QC limits <u>Corrective Action</u> : Flag data outside of limit	9056A	<u>Frequency</u> : 1 with each batch of samples processed not to exceed 20 samples <u>Criteria</u> : Percent recovery must be within laboratory control limits <u>Corrective Action</u> : Flag associated data associated with MS outside of limits
	Matrix Spike Duplicate	365.3 365.1 SM4500P-E	<u>Frequency</u> : 1 per 20 samples <u>Criteria</u> : Must be within laboratory QC limits <u>Corrective Action</u> : Flag data outside of limit	9056A	N/A

INORGANIC LABORATORY QUALITY CONTROL SAMPLES (Cont'd)

Analysis	QC Sample	Method	NPDES ¹	Method	RCRA (SW846) ²
Phosphorus (Total and Ortho-phosphate) (Cont'd)	Duplicate	300.0 ^(4,5) 365.3 365.1 SM4500P-E	N/A	9056A	<u>Frequency</u> : 1 with each batch of samples processed <u>Criteria</u> : RPD ⁽³⁾ must be within laboratory control limits <u>Corrective Action</u> : Flag data associated with duplicates outside of laboratory RPD ⁽³⁾ limits
Solids	* Method Blank	160.1 160.2 160.3 160.4 160.5 SM2540E	<u>Frequency</u> : 1 with each batch of samples processed not to exceed 20 samples <u>Criteria</u> : Concentration must be less than the reporting limit <u>Corrective Action</u> : If analyte level in method blank is \geq RL for the analyte of interest in the sample, all associated samples with reportable levels of analyte are reprepared and reanalyzed.	—	N/A
	Laboratory Control Sample	160.1 160.2 160.3 160.4 160.5 SM2540E	<u>Frequency</u> : 1 with each batch of samples processed not to exceed 20 samples <u>Criteria</u> : Percent recovery must be within laboratory control limits <u>Corrective Action</u> : If not within laboratory control limits, reprepare and rerun all associated samples	—	N/A

INORGANIC LABORATORY QUALITY CONTROL SAMPLES (Cont'd)

Analysis	QC Sample	Method	NPDES ¹	Method	RCRA (SW846) ²
Solids (Cont'd)	Matrix Spike	160.1 160.2 160.3 160.4 160.5 SM4500P-E	N/A	—	N/A
	Matrix Spike Duplicate	160.1 160.2 160.3 160.4 160.5 SM4500P-E	N/A	—	N/A
	Duplicate	160.1 160.2 160.3 160.4 160.5 SM4500P-E	<u>Frequency:</u> 1 with each batch of samples processed not to exceed 10 samples <u>Criteria:</u> Sample results should agree within 20% if both the sample and sample duplicate results are > 5 X RL <u>Corrective Action:</u> Flag data outside of limit	—	N/A

INORGANIC LABORATORY QUALITY CONTROL SAMPLES (Cont'd)

Analysis	QC Sample	Method	NPDES ¹	Method	RCRA (SW846) ²
Sulfate	* Method Blank	300.0A ⁽⁵⁾ 375.4	<u>Frequency:</u> 1 with each batch of samples processed not to exceed 20 samples <u>Criteria:</u> Concentration must be less than the reporting limit <u>Corrective Action:</u> Rerun all samples associated with unacceptable blank	9038 9056A	<u>Frequency:</u> 1 with each batch of samples processed not to exceed 20 samples <u>Criteria:</u> Concentration must be less than the reporting limit <u>Corrective Action:</u> Rerun all samples associated with unacceptable blank
	Laboratory Control Sample	300.0A ⁽⁵⁾ 375.4	<u>Frequency:</u> 1 with each batch of samples processed not to exceed 20 samples <u>Criteria:</u> Percent recovery must be within laboratory control limits <u>Corrective Action:</u> If not within laboratory control limits, rerun all associated samples	9038 9056A	<u>Frequency:</u> 1 with each batch of samples processed not to exceed 20 samples <u>Method 9038 Criteria:</u> Percent recovery must be within $\pm 15\%$ <u>Method 9056 Criteria:</u> Percent recovery must be within laboratory control limits <u>Corrective Action:</u> Rerun all samples associated with unacceptable LCS (ICV)

INORGANIC LABORATORY QUALITY CONTROL SAMPLES (Cont'd)

Analysis	QC Sample	Method	NPDES ¹	Method	RCRA (SW846) ²
Sulfate (cont'd)	Matrix Spike	300.0A ⁽⁵⁾ 375.4	<u>Frequency:</u> 1 per 10 samples, minimum of one per batch of samples processed <u>Criteria:</u> Percent recovery must be within laboratory control limits <u>Corrective Action:</u> Flag data outside of limit	9038 9056A	<u>Frequency:</u> 1 with each batch of samples processed not to exceed 10 samples (9038) or 20 samples (9056) <u>Method 9038 Criteria:</u> Limits are 75% - 125% recovery <u>Method 9056 Criteria:</u> Percent recovery must be within laboratory control limits <u>Corrective Action:</u> Flag data associated with unacceptable Matrix Spike
	Matrix Spike Duplicate	300.0A ⁽⁵⁾ 375.4	<u>Frequency:</u> 1 per 20 samples, minimum of one per batch of samples processed <u>Criteria:</u> Percent recovery must be within laboratory control limits <u>Corrective Action:</u> Flag data outside of limit	9038 9056A	N/A
	Duplicate	300.0A ⁽⁵⁾ 375.4	N/A	9038 9056A	N/A
Sulfide	* Method Blank	376.1	<u>Frequency:</u> 1 with each batch of samples processed not to exceed 20 samples <u>Criteria:</u> Concentration must be less than the reporting limit <u>Corrective Action:</u> Rerun all samples associated with unacceptable blank	9030A	<u>Frequency:</u> 1 with each batch of samples processed not to exceed 20 samples <u>Criteria:</u> Concentration must be less than the reporting limit <u>Corrective Action:</u> Rerun all samples associated with unacceptable blank

INORGANIC LABORATORY QUALITY CONTROL SAMPLES (Cont'd)

Analysis	QC Sample	Method	NPDES ¹	Method	RCRA (SW846) ²
Sulfide (Cont'd)	Laboratory Control Sample	376.1	<u>Frequency:</u> 1 with each batch of samples processed not to exceed 20 samples <u>Criteria:</u> Percent recovery must be within laboratory control limits <u>Corrective Action:</u> If not within laboratory control limits, rerun all associated samples	9030A	<u>Frequency:</u> 1 with each batch of samples processed not to exceed 20 samples <u>Criteria:</u> Percent recovery must be within laboratory control limits <u>Corrective Action:</u> Flag associated data
	Matrix Spike	376.1	<u>Frequency:</u> 1 with each batch of samples processed not to exceed 20 samples <u>Criteria:</u> Percent recovery must be within laboratory control limits <u>Corrective Action:</u> Flag data outside of limit	9030A	<u>Frequency:</u> 1 with each batch of samples processed not to exceed 20 samples <u>Criteria:</u> Percent recovery must be within laboratory control limits <u>Corrective Action:</u> Flag associated data
	Matrix Spike Duplicate	376.1	<u>Frequency:</u> 1 with each batch of samples processed not to exceed 20 samples <u>Criteria:</u> Percent recovery must be within laboratory control limits <u>Corrective Action:</u> Flag data outside of limit	9030A	<u>Frequency:</u> 1 with each batch of samples processed not to exceed 20 samples <u>Criteria:</u> Percent recovery must be within laboratory control limits <u>Corrective Action:</u> Flag associated data Method 9034: Not Applicable
	Duplicate	376.1	N/A	9030A	N/A

INORGANIC LABORATORY QUALITY CONTROL SAMPLES (Cont'd)

Analysis	QC Sample	Method	NPDES ¹	Method	RCRA (SW846) ²
Total Organic Carbon (TOC)	* Method Blank	415.1 SM5310D	<u>Frequency:</u> 1 with each batch of samples processed not to exceed 20 samples <u>Criteria:</u> Concentration must be less than the reporting limit <u>Corrective Action:</u> Rerun all samples associated with unacceptable blank	9060 Walkley-Black	<u>Frequency:</u> 1 with each batch of samples processed not to exceed 20 samples <u>Criteria:</u> Concentration less than reporting limit <u>Corrective Action:</u> Rerun all samples associated with unacceptable blank
	Laboratory Control Sample	415.1 SM5310D	<u>Frequency:</u> 1 with each batch of samples processed not to exceed 20 samples <u>Criteria:</u> Percent recovery must be within laboratory control limits <u>Corrective Action:</u> If not within laboratory control limits, rerun all associated samples	9060 Walkley-Black	<u>Frequency:</u> 1 with each batch of samples processed not to exceed 20 samples <u>Criteria:</u> percent recovery must be within laboratory control limits <u>Corrective Action:</u> Rerun all samples associated with unacceptable LCS
	Matrix Spike	415.1 SM5310D	<u>Frequency:</u> 1 per 20 samples, minimum of one per batch of samples processed <u>Criteria:</u> Percent recovery must be within laboratory control limits <u>Corrective Action:</u> Flag data outside of limit	9060 Walkley-Black	<u>Frequency:</u> 1 with each batch of samples processed not to exceed 20 samples <u>Criteria:</u> Percent recovery must be within laboratory control limits <u>Corrective Action:</u> Reanalyze if sample remaining. If not, flag data associated with unacceptable Matrix Spike

INORGANIC LABORATORY QUALITY CONTROL SAMPLES (Cont'd)

Analysis	QC Sample	Method	NPDES ¹	Method	RCRA (SW846) ²
Total Organic Carbon (TOC) (cont'd)	Matrix Spike Duplicate	415.1 SM5310D	<u>Frequency:</u> 1 per 20 samples, minimum of one per batch of samples processed <u>Criteria:</u> Percent recovery must be within laboratory control limits <u>Corrective Action:</u> Flag data outside of limit	9060 Walkley-Black	<u>Frequency:</u> 1 with each batch of samples processed not to exceed 20 samples <u>Criteria:</u> Percent recovery must be within laboratory control limits <u>Corrective Action:</u> Reanalyze if sample remaining. If not, flag data associated with unacceptable Matrix Spike Duplicate
	Duplicate	415.1 SM5310D	N/A	9060 Walkley-Black	Not Applicable
Total Organic Halides (TOX)	* Method Blank	450.1 ⁽⁵⁾	<u>Frequency:</u> 1 with each set of 8 samples <u>Criteria:</u> Concentration less than reporting limit <u>Corrective Action:</u> Rerun all samples associated with unacceptable blank	9020B	<u>Frequency:</u> Run in duplicate between each group of 8 analytical determinations <u>Criteria:</u> Concentration less than reporting limit or less than 2 X MDL or RL whichever is lower <u>Corrective Action:</u> Rerun all samples associated with unacceptable blank
	Laboratory Control Sample	450.1 ⁽⁵⁾	<u>Frequency:</u> 1 with each batch of samples processed not to exceed 20 samples <u>Criteria:</u> Percent recovery of analyte must be within laboratory control limits <u>Corrective Action:</u> Rerun all samples associated with unacceptable LCS (ICV)	9020B	<u>Frequency:</u> 1 with each batch of samples processed not to exceed 20 samples <u>Criteria:</u> Percent recovery of analyte must be within 90-110% <u>Corrective Action:</u> Rerun all samples associated with unacceptable LCS (ICV)

INORGANIC LABORATORY QUALITY CONTROL SAMPLES (Cont'd)

Analysis	QC Sample	Method	NPDES ¹	Method	RCRA (SW846) ²
Total Organic Halides (TOX) (cont'd)	Matrix Spike	450.1 ⁽⁵⁾	<u>Frequency:</u> 1 per 20 samples, minimum of one per batch of samples processed <u>Criteria:</u> Must be within laboratory control limits <u>Corrective Action:</u> Reanalyze if sample remaining. If not, flag data with unacceptable Matrix Spike	9020B	<u>Frequency:</u> 1 per batch of 10 samples <u>Criteria:</u> Must be within laboratory control limits <u>Corrective Action:</u> Flag data associated with unacceptable Matrix Spike SOP NO. CORP-WC-0001
	Matrix Spike Duplicate	450.1 ⁽⁵⁾	<u>Frequency:</u> 1 per 20 samples, minimum of one per batch of samples processed <u>Criteria:</u> Must be within laboratory control limits <u>Corrective Action:</u> Reanalyze if sample remaining. If not, flag data with unacceptable Matrix Spike	9020B	N/A
	Duplicate	450.1 ⁽⁵⁾	N/A	9020B	N/A
Turbidity	* Method Blank	180.1	<u>Frequency:</u> 1 with each batch of samples processed not to exceed 20 samples <u>Criteria:</u> Concentration must be less than the reporting limit <u>Corrective Action:</u> Rerun all samples associated with unacceptable blank	—	N/A

INORGANIC LABORATORY QUALITY CONTROL SAMPLES (Cont'd)

Analysis	QC Sample	Method	NPDES ¹	Method	RCRA (SW846) ²
Turbidity (cont'd)	Laboratory Control Sample	180.1	<u>Frequency:</u> 1 with each batch of samples processed not to exceed 20 samples <u>Criteria:</u> Percent recovery must be within laboratory control limits <u>Corrective Action:</u> If not within laboratory control limits, rerun all associated samples	—	N/A
	Matrix Spike	180.1	N/A	—	N/A
	Matrix Spike Duplicate	180.1	N/A	—	N/A
	Duplicate	180.1	<u>Frequency:</u> 1 per 10 samples <u>Criteria:</u> Must be within laboratory QC limits <u>Corrective Action:</u> Flag data outside of limit Not Applicable.	—	N/A
Mercury by CVAA & CVAFS	* Method Blank	200 series 1631E	<u>Frequency:</u> 1 with each batch of samples processed not to exceed 20 samples <u>Criteria:</u> Concentration less than reporting limit <u>Corrective Action:</u> Rerun all samples associated with unacceptable blank, unless the blank is above RL, and samples are ND.	7000A series	<u>Frequency:</u> 1 with each batch of samples processed not to exceed 20 samples <u>Criteria:</u> Concentration less than reporting limit <u>Corrective Action:</u> Rerun all samples associated with unacceptable blank, unless the blank is above RL and samples are ND.

INORGANIC LABORATORY QUALITY CONTROL SAMPLES (Cont'd)

Analysis	QC Sample	Method	NPDES ¹	Method	RCRA (SW846) ²
Mercury by CVAA & CVAFS (Cont'd)	Laboratory Control Sample	200 series 1631E	<p><u>Frequency:</u> 1 with each batch of samples processed not to exceed 20 samples</p> <p><u>Criteria:</u> percent recovery of analyte must be within ± 20 %. 1631E is ± 23%</p> <p><u>Corrective Action:</u> Rerun all samples associated with unacceptable LCS, unless samples are ND, results are reported.</p>	7000A series	<p><u>Frequency:</u> 1 with each batch of samples processed not to exceed 20 samples</p> <p><u>Criteria:</u> percent recovery of analyte must be within ± 20 %</p> <p><u>Corrective Action:</u> Rerun all samples associated with unacceptable LCS, unless MT-0003. Exception: If samples are ND, results are reported.</p>
	Matrix Spike	200 series 1631E	<p><u>Frequency:</u> with each batch of samples processed not to exceed 20 samples. 1631E frequency is 1 in 10 samples, 71-125%</p> <p><u>Criteria:</u> Recovery should be within 75-125 %</p> <p><u>Corrective Action:</u> Flag data associated with unacceptable MS.</p>	7000A series	<p><u>Frequency:</u> 1 with each batch of samples processed not to exceed 20 samples</p> <p><u>Criteria:</u> Recovery should be within 75-125 %</p> <p><u>Corrective Action:</u> Flag data associated with unacceptable MS.</p>
	Matrix Spike Duplicate	200 series 1631E	<p><u>Frequency:</u> 1 with each batch of samples processed not to exceed 20 samples. 1631E frequency is 1 in 10 samples, 71-125% RPD 24%</p> <p><u>Criteria:</u> Recovery should be within 75-125 % , RPD⁽³⁾ should be within 20%</p> <p><u>Corrective Action:</u> Flag data associated with unacceptable MSD</p>	7000A series	<p><u>Frequency:</u> 1 with each batch of samples processed not to exceed 20 samples</p> <p><u>Criteria:</u> Recovery should be within 75-125 % , RPD⁽³⁾ should be within 20%</p> <p><u>Corrective Action:</u> Flag data associated with unacceptable MSD</p>

INORGANIC LABORATORY QUALITY CONTROL SAMPLES (Cont'd)

Analysis	QC Sample	Method	NPDES ¹	Method	RCRA (SW846) ²
Mercury by CVAA & CVAFS (Cont'd)	Duplicate	200 series 1631E	N/A	7000A series	N/A
ICP Metals	* Method Blank	200.7 200.8	<p><u>Frequency:</u> 1 with each batch of samples processed not to exceed 20 samples</p> <p><u>Criteria:</u> Concentration less than reporting limit. Concentration less than reporting with the exception of lab common contaminants. Sample results <RL are also valid.</p> <p><u>Corrective Action:</u> Rerun all samples associated with unacceptable blank unless the blank is above RL, and samples are ND. SOP NC-MT-012</p>	6010B 6020	<p><u>Frequency:</u> 1 with each batch of samples processed not to exceed 20 samples</p> <p><u>Criteria:</u> Concentration less than reporting limit. Concentration less than reporting with the exception of lab common contaminants. Sample results <RL are also valid.</p> <p><u>Corrective Action:</u> Rerun all samples associated with unacceptable blank unless the blank is above RL, and samples are ND. SOP NC-MT-012</p>
	Laboratory Control Sample	200.7 200.8	<p><u>Frequency:</u> 1 with each batch of samples processed not to exceed 20 samples</p> <p><u>Criteria:</u> percent recovery of analyte must be \pm 85-115%. If LCS is biased high and samples are <RL, the results are valid.</p> <p><u>Corrective Action:</u> Rerun all samples associated with unacceptable LCS SOP NC-MT-012</p>	6010B 6020	<p><u>Frequency:</u> 1 with each batch of samples processed not to exceed 20 samples</p> <p><u>Criteria:</u> percent recovery of analyte must be \pm 20 %. If LCS is biased high and samples are <RL, the results are valid.</p> <p><u>Corrective Action:</u> Rerun all samples associated with unacceptable LCS SOP NC-MT-012. If samples are ND, results are reported.</p>

INORGANIC LABORATORY QUALITY CONTROL SAMPLES (Cont'd)

Analysis	QC Sample	Method	NPDES ¹	Method	RCRA (SW846) ²
ICP Metals (Cont'd)	Matrix Spike	200.7 200.8	Frequency: 1 with each batch of samples processed not to exceed 20 samples <u>Criteria:</u> Limits for percent recovery are 75-125% <u>Corrective Action:</u> Flag data associated with unacceptable matrix spike SOP NC-MT-012	6010B 6020	Frequency: 1 with each batch of samples processed not to exceed 20 samples <u>Criteria:</u> Limits for percent recovery are 75-125% <u>Corrective Action:</u> Flag data associated with unacceptable matrix spike SOP NC-MT-012
	Matrix Spike Duplicate	200.7 200.8	Frequency: 1 with each batch of samples processed not to exceed 20 samples <u>Criteria:</u> Limits for percent recovery are 75-125%, RPD ⁽³⁾ must be within 20% <u>Corrective Action:</u> Flag data associated with unacceptable matrix spike SOP NC-MT-012	6010B 6020	Frequency: 1 with each batch of samples processed not to exceed 20 samples <u>Criteria:</u> Limits for percent recovery are 75-125%, RPD ⁽³⁾ must be within 20% <u>Corrective Action:</u> Flag data associated with unacceptable matrix spike SOP NC-MT-012
	Duplicate	200.7 200.8	Not Applicable	6010B 6020	Not Applicable
	Serial Dilution	200.7 200.8	Frequency: 1 with each batch of samples processed not to exceed 20 samples <u>Criteria:</u> 10% difference. 10% difference only applied if sample results are >50 times IDL. <u>Corrective Action:</u> Flag data associated with unacceptable serial dilution SOP NC-MT-012	6010B 6020	Frequency: 1 with each batch of samples processed not to exceed 20 samples <u>Criteria:</u> 10% difference. 10% difference only applied if sample results are >50 times IDL. <u>Corrective Action:</u> Flag data associated with unacceptable serial dilution SOP NC-MT-012

INORGANIC LABORATORY QUALITY CONTROL SAMPLES (Cont'd)

Footnotes

- ¹ National Pollutant Discharge Elimination System
- ² Resource Conservation and Recovery Act, Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, (SW-846), Third Edition, September 1986. Contains Final Update I (July 1992), Final Update IIA (August 1993), Final Update II (September 1994), Final Update IIB (January 1995), and Final Update III (December 1996).
- ³ RPD-Relative Percent Difference
- ⁴ Orthophosphate only
- ⁵ Method not listed in 40 CFR Part 136. Method 300.0 is a proposed 40CFR method. Specific state and/or region approval is required for NPDES.
- ⁶ Current promulgated method is a Guidance Method Only, SW-846, Final Update III, Rev.3, 12/96.

ORGANIC LABORATORY QUALITY CONTROL SAMPLES

Analysis	QC Sample	Method	NPDES ¹	Method	RCRA (SW846) ²
Aromatic Volatiles by GC	* Method Blank	602	<u>Frequency:</u> 1 with each batch of samples processed not to exceed 20 samples <u>Criteria:</u> Concentration less than reporting limit <u>Corrective Action:</u> Rerun all samples associated with unacceptable blank	8021B	<u>Frequency:</u> 1 with each batch of samples processed not to exceed 20 samples <u>Criteria:</u> Concentration less than reporting limit <u>Corrective Action:</u> Rerun all samples associated with unacceptable blank
	Laboratory Control Sample	602	<u>Frequency:</u> 1 with each batch of samples processed not to exceed 20 samples <u>Criteria:</u> percent recovery must be within acceptance limits given in method for each analyte <u>Corrective Action:</u> Rerun all samples associated with unacceptable LCS	8021B	<u>Frequency:</u> 1 with each batch of samples processed not to exceed 20 samples <u>Criteria:</u> percent recovery for each analyte must be within laboratory acceptance limits <u>Corrective Action:</u> Rerun all samples associated with unacceptable LCS
	Matrix Spike	602	<u>Frequency:</u> 1 per 10 samples from each site or 1 per month, whichever is more frequent <u>Criteria:</u> percent recovery for each analyte should be within advisory limits given in method <u>Corrective Action:</u> Flag data associated with unacceptable Matrix Spike	8021B	<u>Frequency:</u> 1 with each batch of samples processed not to exceed 20 samples <u>Criteria:</u> percent recovery for each analyte should be within laboratory acceptance limits <u>Corrective Action:</u> Flag data associated with unacceptable Matrix Spike

ORGANIC LABORATORY QUALITY CONTROL SAMPLES (Cont'd)

Analysis	QC Sample	Method	NPDES ¹	Method	RCRA (SW846) ²
Aromatic Volatiles by GC (Cont'd)	Matrix Spike Duplicate	602	N/A	8021B	<p><u>Frequency:</u> 1 with each batch of samples processed not to exceed 20 samples</p> <p><u>Criteria:</u> percent recovery for each analyte should be within laboratory acceptance limits</p> <p><u>Corrective Action:</u> Flag data associated with unacceptable Matrix Spike</p>
	Duplicate	602	N/A	8021B	N/A
	Surrogates	602	<p>Surrogates spiked into method blank and all samples (QC included)</p> <p><u>Method Blank Criteria and LCS:</u> All surrogates must be within laboratory established control limits before sample analysis may proceed.</p> <p><u>Sample Criteria:</u> Re-extract samples or flag sample data not meeting surrogate criteria</p>	8021B	<p>Surrogates spiked into method blank and all samples (QC included)</p> <p><u>Method Blank Criteria and LCS:</u> All surrogates must be within laboratory established control limits before sample analysis may proceed.</p> <p><u>Sample Criteria:</u> Reprep and reanalyze samples or flag sample data not meeting surrogate criteria</p>
	Internal Standards	602	Optional: Internal standards are added to the method blank and all samples (QC included).	8021B	Optional: Internal standards are added to the method blank and all samples (QC included). If used, same compounds as used for surrogates may be appropriate.

ORGANIC LABORATORY QUALITY CONTROL SAMPLES (Cont'd)

Analysis	QC Sample	Method	NPDES¹	Method	RCRA (SW846)²
Halogenated Volatiles by GC	* Method Blank	--	N/A	8021B	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: Concentration less than reporting limit Corrective Action: Rerun all samples associated with unacceptable blank
	Laboratory Control Sample	--	N/A	8021B	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: percent recovery for each analyte must be within laboratory acceptance limits Corrective Action: Rerun all samples associated with unacceptable LCS
	Matrix Spike	--	N/A	8021B	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: percent recovery for each analyte should be within laboratory acceptance limits Corrective Action: Flag data associated with unacceptable Matrix Spike
	Matrix Spike Duplicate	--	N/A	8021B	Frequency: 1 with each batch of samples processed not to exceed 20 samples Criteria: percent recovery for each analyte should be within laboratory acceptance limits Corrective Action: Flag data associated with unacceptable Matrix Spike

ORGANIC LABORATORY QUALITY CONTROL SAMPLES (Cont'd)

Analysis	QC Sample	Method	NPDES ¹	Method	RCRA (SW846) ²
Halogenated Volatiles by GC (Cont'd)	Duplicate	--	N/A	8021B	N/A
	Surrogates	--	N/A	8021B	<p>Surrogates spiked into method blank and all samples (QC included)</p> <p><u>Method Blank Criteria and LCS:</u> All surrogates must be within laboratory established control limits before sample analysis may proceed.</p> <p><u>Sample Criteria:</u> Reprep and reanalyze samples or flag sample data not meeting surrogate criteria.</p>
	Internal Standards	--	N/A	8021B	Optional: Internal standards are added to the method blank and all samples (QC included). If used, same compounds as used for surrogates may be appropriate.

ORGANIC LABORATORY QUALITY CONTROL SAMPLES (Cont'd)

Analysis	QC Sample	Method	NPDES ¹	Method	RCRA (SW846) ²
Herbicides	Laboratory Control Sample	615 ³	<u>Frequency:</u> 1 with each extraction batch of samples not to exceed 20 samples <u>Criteria:</u> Percent recovery must be within acceptance limits given in method for each analyte <u>Corrective Action:</u> Re-extract all samples associated with unacceptable LCS	8151A	<u>Frequency:</u> 1 with each extraction batch of samples not to exceed 20 samples <u>Criteria:</u> Percent recovery for each analyte must be within laboratory acceptance limits <u>Corrective Action:</u> Re-extract and reanalyze all samples associated with unacceptable LCS
	Matrix Spike	615 ³	<u>Frequency:</u> 1 per 10 samples from each site or 1 per month, whichever is more frequent <u>Criteria:</u> Percent recovery for each analyte should be within advisory limits given in method <u>Corrective Action:</u> Flag data associated with unacceptable Matrix Spike	8151A	<u>Frequency:</u> 1 with each extraction batch of samples not to exceed 20 samples <u>Criteria:</u> Percent recovery for each analyte should be within laboratory acceptance limits <u>Corrective Action:</u> Flag data associated with unacceptable Matrix Spike
	Matrix Spike Duplicate	615 ³	N/A	8151A	<u>Frequency:</u> 1 with each extraction batch of samples not to exceed 20 samples <u>Criteria:</u> percent recovery for each analyte should be within laboratory control limits <u>Corrective Action:</u> Flag data associated with unacceptable matrix spike sample

ORGANIC LABORATORY QUALITY CONTROL SAMPLES (Cont'd)

Analysis	QC Sample	Method	NPDES ¹	Method	RCRA (SW846) ²
Herbicides (cont'd)	Duplicate	615 ³	N/A	8151A	N/A
	Surrogates	615 ³	N/A	8151A	Surrogates spiked into method blank and all samples (QC included) <u>Method Blank Criteria and LCS:</u> All surrogates must fall within laboratory established control limits before sample analysis may proceed. <u>Sample Criteria:</u> Re-extract and reanalyze samples or flag sample data not meeting surrogate criteria
	Internal Standards	615 ³	N/A	8151A	Optional
Pesticides/ PCBs	* Method Blank	608	Frequency: 1 with each extraction batch of samples not to exceed 20 samples <u>Criteria:</u> Concentration less than reporting limit <u>Corrective Action:</u> Rerun all samples associated with unacceptable blank	8081A 8082	Frequency: 1 with each extraction batch of samples not to exceed 20 samples <u>Criteria:</u> Concentration less than reporting limit <u>Corrective Action:</u> Reprepare and reanalyze all samples associated with unacceptable blank

ORGANIC LABORATORY QUALITY CONTROL SAMPLES (Cont'd)

Analysis	QC Sample	Method	NPDES ¹	Method	RCRA (SW846) ²
Pesticides/ PCBs (Cont'd)	Laboratory Control Sample	608	<u>Frequency:</u> 1 with each extraction batch of samples not to exceed 20 samples <u>Criteria:</u> percent recovery must be within acceptance limits given in method for each analyte <u>Corrective Action:</u> Rerun all samples associated with unacceptable LCS	8081A 8082	<u>Frequency:</u> 1 with each extraction batch of samples not to exceed 20 samples <u>Criteria:</u> percent recovery for each analyte must be within laboratory acceptance limits <u>Corrective Action:</u> Rerun all samples associated with unacceptable LCS
	Matrix Spike	608	<u>Frequency:</u> 1 per 10 samples from each site or 1 per month, whichever is more frequent <u>Criteria:</u> percent recovery for each analyte should be within advisory limits given in method <u>Corrective Action:</u> Flag data associated with unacceptable Matrix Spike	8081A 8082	<u>Frequency:</u> 1 with each extraction batch of samples not to exceed 20 samples <u>Criteria:</u> percent recovery for each analyte should be within laboratory acceptance limits <u>Corrective Action:</u> Flag data associated with unacceptable Matrix Spike

ORGANIC LABORATORY QUALITY CONTROL SAMPLES (Cont'd)

Analysis	QC Sample	Method	NPDES ¹	Method	RCRA (SW846) ²
Pesticides/ PCBs (cont'd)	Matrix Spike Duplicate	608	N/A	8081A 8082	<u>Frequency:</u> 1 with each extraction batch of samples not to exceed 20 samples <u>Criteria:</u> percent recovery for each analyte should be within laboratory acceptance limits <u>Corrective Action:</u> Flag data associated with unacceptable Matrix Spike
	Duplicate	608	N/A	8081A 8082	N/A
	Surrogates	608	Not specified in method	8081A 8082	Surrogates spiked into method blank and all samples (QC included) <u>Method Blank Criteria and LCS:</u> Results must fall within laboratory established control limits <u>Sample Criteria:</u> Re-extract and reanalyze samples or flag sample data not meeting surrogate criteria
Petroleum Hydro- carbons	* Method Blank	1664A	<u>Frequency:</u> 1 with each preparation batch <u>Criteria:</u> Concentration must be less than the reporting limit <u>Corrective Action:</u> Rerun all samples associated with unacceptable blank	9071B	<u>Frequency:</u> 1 with each preparation batch <u>Criteria:</u> Concentration must be less than the reporting limit <u>Corrective Action:</u> Rerun all samples associated with unacceptable blank

ORGANIC LABORATORY QUALITY CONTROL SAMPLES (Cont'd)

Analysis	QC Sample	Method	NPDES ¹	Method	RCRA (SW846) ²
Petroleum Hydrocarbons (Cont'd)	Laboratory Control Sample	1664A	<u>Frequency:</u> 1 with each analytical batch <u>Criteria:</u> Waters - See limits in SOP, NC-WC-0084 Soils - Percent recovery must be within laboratory control limits <u>Corrective Action:</u> Rerun all samples associated with unacceptable LCS	9071B	<u>Frequency:</u> 1 with each analytical batch <u>Criteria:</u> Waters - See limits in SOP, NC-WC-0084 Soils - Percent recovery must be within laboratory control limits <u>Corrective Action:</u> Rerun all samples associated with unacceptable LCS
	Matrix Spike	1664A	<u>Frequency:</u> 1 with every 10 samples per site <u>Criteria:</u> See percent recovery limits in SOP, NC-WC-0084 <u>Corrective Action:</u> See SOP, NC-WC-0084	9071B	<u>Frequency:</u> 1 with every 10 samples per site <u>Criteria:</u> See percent recovery limits in SOP, NC-WC-0084 <u>Corrective Action:</u> See SOP, NC-WC-0084
	Matrix Spike Duplicate	1664A	<u>Frequency:</u> 1 with every 20 samples per site <u>Criteria:</u> See percent recovery and RPD limits in SOP, NC-WC-0084 <u>Corrective Action:</u> See NC-WC-0084	9071B	<u>Frequency:</u> 1 with every 10 samples per site <u>Criteria:</u> See percent recovery and RPD limits in SOP, NC-WC-0084 <u>Corrective Action:</u> See NC-WC-0084
	Duplicate	1664A	N/A	9071B	N/A

ORGANIC LABORATORY QUALITY CONTROL SAMPLES (Cont'd)

Analysis	QC Sample	Method	NPDES ¹	Method	RCRA (SW846) ²
Purgeable Halocarbons by GC	* Method Blank	601	<u>Frequency:</u> 1 with each extraction batch of samples not to exceed 20 samples <u>Criteria:</u> Concentration less than reporting limit <u>Corrective Action:</u> Rerun all samples associated with unacceptable blank	8021B	<u>Frequency:</u> 1 with each extraction batch of samples not to exceed 20 samples <u>Criteria:</u> Concentration less than reporting limit <u>Corrective Action:</u> Rerun all samples associated with unacceptable blank
	Laboratory Control Sample	601	<u>Frequency:</u> 1 with each extraction batch of samples not to exceed 20 samples <u>Criteria:</u> percent recovery must be within acceptance limits given in method for each analyte <u>Corrective Action:</u> Rerun all samples associated with unacceptable LCS	8021B	<u>Frequency:</u> 1 with each extraction batch of samples not to exceed 20 samples <u>Criteria:</u> percent recovery for each analyte must be within laboratory acceptance limits <u>Corrective Action:</u> Rerun all samples associated with unacceptable LCS
	Matrix Spike	601	<u>Frequency:</u> 1 per 10 samples from each site or 1 per month, whichever is more frequent <u>Criteria:</u> percent recovery for each analyte should be within advisory limits given in method <u>Corrective Action:</u> Flag data associated with unacceptable Matrix Spike	8021B	<u>Frequency:</u> 1 with each extraction batch of samples not to exceed 20 samples <u>Criteria:</u> percent recovery for each analyte should be within laboratory acceptance limits <u>Corrective Action:</u> Flag data associated with unacceptable Matrix Spike

ORGANIC LABORATORY QUALITY CONTROL SAMPLES (Cont'd)

Analysis	QC Sample	Method	NPDES ¹	Method	RCRA (SW846) ²
Purgeable Halocarbons by GC (Cont'd)	Matrix Spike Duplicate	601	N/A	8021B	<u>Frequency:</u> 1 with each extraction batch of samples not to exceed 20 samples <u>Criteria:</u> percent recovery for each analyte should be within laboratory acceptance limits <u>Corrective Action:</u> Flag data associated with unacceptable Matrix Spike
	Duplicate	601	N/A	8021B	N/A
	Surrogates	601	Surrogates spiked into method blank and all samples (QC included) <u>Method Blank Criteria and LCS:</u> All surrogates must be within laboratory established control limits before sample analysis may proceed. <u>Sample Criteria:</u> Re-extract samples or flag sample data not meeting surrogate criteria	8021B	Surrogates spiked into method blank and all samples (QC included) <u>Method Blank Criteria and LCS:</u> All surrogates must be within laboratory established control limits before sample analysis may proceed. <u>Sample Criteria:</u> Re-extract and reanalyze samples or flag sample data not meeting surrogate criteria
	Internal Standards	601	Optional: Internal standards are added to the method blank and all samples (QC included). If used, same compounds as used for surrogates may be appropriate.	8021B	Optional: Internal standards are added to the method blank and all samples (QC included). If used, same compounds as used for surrogates may be appropriate.

ORGANIC LABORATORY QUALITY CONTROL SAMPLES (Cont'd)

Analysis	QC Sample	Method	NPDES ¹	Method	RCRA (SW846) ²
Semivolatiles	Matrix Spike	625	<u>Frequency:</u> 1 with each extraction batch of samples not to exceed 20 samples <u>Criteria:</u> percent recovery for each analyte should be within advisory limits given in method <u>Corrective Action:</u> Flag data associated with unacceptable Matrix Spike	8270C	<u>Frequency:</u> 1 with each extraction batch of samples not to exceed 20 samples <u>Criteria:</u> percent recovery for each analyte should be within laboratory acceptance limits <u>Corrective Action:</u> Flag data associated with unacceptable Matrix Spike
	Matrix Spike Duplicate	625	N/A	8270C	<u>Frequency:</u> 1 with each extraction batch of samples not to exceed 20 samples <u>Criteria:</u> percent recovery for each analyte should be within laboratory acceptance limits <u>Corrective Action:</u> Flag data associated with unacceptable Matrix Spike

ORGANIC LABORATORY QUALITY CONTROL SAMPLES (Cont'd)

Analysis	QC Sample	Method	NPDES ¹	Method	RCRA (SW846) ²
Semivolatiles (Cont'd)	Duplicate	625	N/A	8270C	N/A
	Surrogates	625	<p>Surrogates spiked into method blank and all samples (QC included)</p> <p><u>Method Blank and LCS Criteria:</u> All surrogates must be in control before sample analysis may proceed. One surrogate per fraction may exceed control limits if greater than 10% recovery.</p> <p><u>Sample Criteria:</u> Re-extract samples or flag sample data not meeting surrogate criteria</p>	8270C	<p>Surrogates spiked into method blank and all samples (QC included)</p> <p><u>Method Blank and LCS Criteria:</u> All surrogates must be in control before sample analysis may proceed. One surrogate per fraction may exceed control limits if greater than 10% recovery.</p> <p><u>Sample Criteria:</u> Re-extract and reanalyze samples or flag sample data not meeting surrogate criteria</p>
	Internal Standards	625	<p><u>Frequency:</u> Internal standards spiked into method blank and all samples (QC included)</p> <p><u>Criteria:</u> All internal standard recoveries must be within laboratory control limits</p> <p><u>Corrective Action:</u> Flag sample data not meeting internal standard recovery requirements</p>	8270C	<p>Internal Standards are added to all samples (QC samples included). Internal standard area of daily standard must be within 50% to 200% of the response in the mid level of the initial calibration standard.</p> <p>The retention time (RT) for any internal standard (IS) in the continuing calibration must not exceed ± 0.5 minutes from mid level initial calibration standard IS RT.</p>

ORGANIC LABORATORY QUALITY CONTROL SAMPLES (Cont'd)

Analysis	QC Sample	Method	NPDES ¹	Method	RCRA (SW846) ²
Volatiles by GC/MS	* Method Blank	624	<u>Frequency:</u> 1 with each batch of samples processed not to exceed 20 samples <u>Criteria:</u> Concentration less than reporting limit <u>Corrective Action:</u> Rerun all samples associated with unacceptable blank	8260B	<u>Frequency:</u> 1 with each batch of samples processed not to exceed 20 samples <u>Criteria:</u> Concentration less than reporting limit <u>Corrective Action:</u> Rerun all samples associated with unacceptable blank
	Laboratory Control Sample	624	<u>Frequency:</u> 1 with each batch of samples processed not to exceed 20 samples <u>Criteria:</u> percent recovery for each analyte should be within advisory limits given in method <u>Corrective Action:</u> Flag data associated with unacceptable Matrix Spike	8260B	<u>Frequency:</u> 1 with each batch of samples processed not to exceed 20 samples <u>Criteria:</u> percent recovery for each analyte must be within laboratory acceptance limits <u>Corrective Action:</u> Rerun all samples associated with unacceptable LCS

ORGANIC LABORATORY QUALITY CONTROL SAMPLES (Cont'd)

Analysis	QC Sample	Method	NPDES ¹	Method	RCRA (SW846) ²
Volatiles by GC/MS (Cont'd)	Matrix Spike	624	<u>Frequency:</u> 1 per ≤ 20 samples from each site or 1 per month, whichever is more frequent <u>Criteria:</u> percent recovery for each analyte should be within advisory limits given in method <u>Corrective Action:</u> Flag data associated with unacceptable Matrix Spike	8260B	<u>Frequency:</u> 1 with each batch of samples processed not to exceed 20 samples <u>Criteria:</u> percent recovery for each analyte should be within laboratory acceptance limits <u>Corrective Action:</u> Flag data associated with unacceptable Matrix Spike
	Matrix Spike Duplicate	624	N/A	8260B	<u>Frequency:</u> 1 with each batch of samples processed not to exceed 20 samples <u>Criteria:</u> percent recovery for each analyte should be within laboratory acceptance limits <u>Corrective Action:</u> Flag data associated with unacceptable Matrix Spike
	Duplicate	624	N/A	8260B	N/A

ORGANIC LABORATORY QUALITY CONTROL SAMPLES (Cont'd)

Analysis	QC Sample	Method	NPDES ¹	Method	RCRA (SW846) ²
Volatiles by GC/MS (cont'd)	Surrogates	624	<p>Surrogates spiked into Method Blank and all samples (QC included)</p> <p><u>Method Blank Criteria:</u> All surrogates must be in control before sample analysis may proceed.</p> <p><u>Sample Criteria:</u> Re-extract samples or flag sample data not meeting surrogate criteria</p>	8260B	<p>Surrogates spiked into Method Blank and all samples (QC included)</p> <p><u>Method Blank Criteria and LCS:</u> All surrogates must be in control before sample analysis may proceed.</p> <p><u>Sample Criteria:</u> Re-extract and reanalyze samples or flag sample data not meeting surrogate criteria</p>
	Internal Standards	624	<p><u>Frequency:</u> Internal standards spiked into method blank and all samples (QC included)</p> <p><u>Criteria:</u> All internal standard recoveries must be within laboratory control limits</p> <p><u>Corrective Action:</u> Flag sample data not meeting internal standard recovery requirements</p>	8260B	<p>Internal Standards are added to all samples (QC samples included).</p> <p>Internal standard area of daily standard must be within 50% to 200% of the response in the mid level of the initial calibration standard.</p> <p>The retention time (RT) for any internal standard (IS) in the continuing calibration must not exceed ± 0.5 minutes from mid level initial calibration standard IS RT.</p>

Footnotes

- ¹ National Pollutant Discharge Elimination System
- ² Resource Conservation and Recovery Act, Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, (SW-846), Third Edition, September 1986. Contains Final Update I (July 1992), Final Update IIA (August 1993), Final Update II (September 1994), Final Update IIB (January 1995), and Final Update III (December 1996)
- ³ Method not listed in 40 CFR Part 136

SECTION 13

PREVENTIVE ACTION (NELAC 5.4.11)

13.1 OVERVIEW

The laboratory's preventive action programs improve, or eliminate potential causes of nonconforming product and/or nonconformance to the quality system. This preventive action process is a proactive continuous process improvement activity that can be initiated through feedback from clients, employees, business providers, and affiliates. The QA Department has the overall responsibility to ensure the preventive action process is in place, and that relevant information on actions is submitted for management review.

Dedicating resources to an effective preventive action system emphasizes the laboratory's commitment to its Quality Program. It is beneficial to identify and address negative trends before they develop into complaints, problems and corrective actions. Additionally, customer service and satisfaction can be improved through continuous improvements to laboratory systems.

Opportunities for improvement may be discovered during management reviews, the QA Metrics Report, internal or external audits, proficiency testing performance, client complaints, staff observation, etc.

The monthly QA Metrics Report shows performance indicators in all areas of the quality system. These areas include revised reports, corrective actions, audit findings, internal auditing and data authenticity audits, client complaints, PT samples, holding time violations, SOPs, Ethics training, etc. These metrics are used to help evaluate quality system performance on an ongoing basis and provide a tool for identifying areas for improvement.

The laboratory's corrective action process (Section 13) is integral to implementation of preventive actions. A critical piece of the corrective action process is the implementation of actions to prevent further occurrence of a non-compliance event. Historical review of corrective action provides a valuable mechanism for identifying preventive action opportunities.

13.1.1 The following elements are part of a preventive action system:

- Identification of an opportunity for preventive action.
- Process for the preventive action.
- Define the measurements of the effectiveness of the process once undertaken.
- Execution of the preventive action.
- Evaluation of the plan using the defined measurements.
- Verification of the effectiveness of the preventive action.
- Close-out by documenting any permanent changes to the Quality System as a result of the Preventive Action. Documentation of Preventive Action is incorporated into the monthly QA reports, corrective action process, and management review.

13.1.2 Any Preventive Actions undertaken or attempted must be taken into account during the Annual Management Review (Section 16). A highly detailed recap is not required; a simple recount of success and failure within the preventive action program will provide management a measure for evaluation.

13.2 MANAGEMENT OF CHANGE

The Management of Change process is designed to manage significant events and changes that occur within the laboratory. Through these procedures, the potential risks inherent with a new event or change are identified and evaluated. The risks are minimized or eliminated through pre-planning and the development of preventive measures. The types of changes covered under this system include: Facility Changes, Major Accreditation Changes, Addition or Deletion to Division's Capabilities or Instrumentation, Key Personnel Changes, Laboratory Information Management System (LIMS) changes. This process is discussed in further detail in SOP CA-Q-S-003, Management of Change.

SECTION 14
CONTROL OF RECORDS
(NELAC 5.4.12)

The laboratory maintains a record system appropriate to its needs and that complies with applicable standards or regulations as required. The system produces unequivocal, accurate records that document all laboratory activities. The laboratory retains all original observations, calculations and derived data, calibration records and a copy of the analytical report for a minimum of five years after it has been issued.

14.1 OVERVIEW

The laboratory has established procedures for identification, collection, indexing, access, filing, storage, maintenance and disposal of quality and technical records. A record index is listed in Table 14-1. Quality records are maintained by the QA Department in a database which is backed up as part of the regular network backup. Records are of two types--either electronic or hard-copy paper formats depending on whether the record is computer or hand generated (some records may be in both formats). Technical records are maintained by the Records Manager.

Table 14-1. Records Index

Type of Record	Retention	Disposition
General Laboratory Documents		
Instrument output	5 yrs from project completion	Shred or burn
Quality control data	5 yrs from project completion*	Shred or burn
Field sample data	5 yrs from project completion	Shred or burn
Final analytical reports	5 yrs from project completion	Shred or burn
Instrument logbooks	5 yrs from last entry	Shred or burn
Equipment monitoring & maintenance records	5 yrs from last entry	Shred or burn
Instrument calibration records	5 yrs from last entry	Shred or burn
Standard preparation logs	5 yrs from last entry	Shred or burn
Standards certificates	5 yrs from last entry	Shred or burn
Measurement & test equipment logs (e.g., refriger., balances, etc.)	5 yrs from last entry	Shred or burn
Method & instrument validation records	5 yrs from last entry	Shred or burn
Instrument manuals	Retain until superseded	Trash
Project management files	5 yrs from date of archival	Shred or burn
Quotes & proposals	2 yrs from date of expiration	Shred or burn
LQM, policies, & SOPs	5 yrs from date of archiving	Shred or burn

Type of Record	Retention	Disposition
Analyst demonstrations of proficiency	5 yrs from date of archival	Shred or burn
Quality assurance audits	5 yrs from last entry	Shred or burn
Certifications & approvals	5 yrs from last entry	Shred or burn
Employee signature list	5 yrs from date of archival	Shred or burn
MDL Studies	5 yrs from last entry	Shred or burn
Performance testing studies	5 yrs from last entry	Shred or burn
QA reports to management	5 yrs from last entry	Shred or burn
Quality control charts	5 yrs from last entry	Shred or burn
Environment, Health and Safety Records		
Medical records	Retain while active & 30 yrs from last entry	Shred or burn
Employee exposure & monitoring records	Retain while active & 30 yrs from last entry	Shred or burn
Workers compensation files & first report of injury	Retain while active & 30 yrs from last entry	Shred or burn
Accident logs (OSHA Form 200)	5 yrs from last entry	Shred or burn
Accident reports	5 yrs from last entry	Shred or burn
Environmental permits	5 yrs from last entry	Shred or burn
Environmental management, e.g., discharge reports	5 yrs from last entry	Shred or burn
Health & safety audits	5 yrs from last entry	Shred or burn
Chemical Hygiene Plan	5yrs from archival	
Safety Inspections	5 yrs from last entry	Shred or burn
TLD exposure records	5 yrs from last entry	Shred or burn
EH&S training	5 yrs from last entry	Shred or burn
Accounting	See Accounting and Controls Procedures Manual	
Administrative		
Personnel records (not including medical or disability records)	7 years from last entry	Shred or burn

* Exceptions listed in Table 14-2.

All records are stored and retained in such a way that they are secure and readily retrievable at the laboratory facility that provides a suitable environment to prevent damage or deterioration and to prevent loss. All records must be protected against fire, theft, loss, environmental deterioration, and vermin. In the case of electronic records and electronic or magnetic sources, storage media are protected from deterioration caused by magnetic fields and/or electronic deterioration.

Access to the data is limited to laboratory and company employees. Records are maintained for a minimum of five years unless otherwise specified by a client or regulatory requirement.

For raw data and project records, record retention must be calculated from the date the project report is issued. For other records, such as Controlled Documents, QA, or Administrative Records, the retention time is calculated from the date the record is formally retired. Records related to the programs listed in Table 14-2 have lengthier retention requirements and are subject to the requirements in Section 14.1.3.

14.1.1 Programs with Longer Retention Requirements

Some regulatory programs have longer record retention requirements than the standard record retention time. These are detailed in Table 14-2 with their retention requirements. In these cases, the longer retention requirement is enacted. If special instructions exist such that client data cannot be destroyed prior to notification of the client, the container or box containing that data is marked as to who to contact for authorization prior to destroying the data.

Note: For the Ohio VAP program the laboratory is required to notify Ohio EPA of its intent to dispose of any records.

Table 14-2. Special Record Retention Requirements

Program	Retention Requirement
Ohio – Drinking Water	10 years
Michigan Department of Environmental Quality – all environmental data	10 years
OSHA - 40 CFR Part 1910	30 years
TSCA - 40 CFR Part 792	10 years after publication of final test rule or negotiated test agreement and others as negotiated.
Ohio Voluntary Action Program	10 years

Note: Extended retention requirements must be noted with the archive documents or addressed in facility-specific records retention procedures.

14.1.2 The laboratory has procedures to protect and back-up records stored electronically and to prevent unauthorized access to or amendment of these records. All analytical data is maintained as hardcopy or in a secure readable electronic format. For analytical reports that are maintained as copies in PDF format, refer to Section 19.12.1 for more information.

14.1.3 The record-keeping system allows for historical reconstruction of all laboratory activities that produced the analytical data, as well as rapid recovery of historical data. (Records stored off site should be accessible within two days of a request for such records). The history of the sample from when the laboratory took possession of the samples must be readily understood through the documentation. This must include inter-laboratory transfers of samples and/or extracts.

- The records include the identity of personnel involved in sampling, sample receipt, preparation, or testing. All analytical work contains the initials (at least) of the personnel involved. The laboratory copy of the Chain-of-Custody is stored with the invoice and the Work Order sheet generated by LIMS. The Chain-of-Custody would indicate the name of the sampler. If any sampling notes are provided with a Work Order, they are kept with this package.
- All information relating to the laboratory facilities equipment, analytical test methods, and related laboratory activities, such as sample receipt, sample preparation, or data verification are documented.
- The record-keeping system facilitates the retrieval of all working files and archived records for inspection and verification purposes, e.g., set format for naming electronic files, set format for what is included with a given analytical data set. SOP NC-QA-019, Records Information Management, outlines this procedure. Instrument data is stored sequentially by instrument. A given day's analyses are maintained in the order of the analysis. Run logs are maintained for each instrument or method; a copy of each day's run long or instrument sequence is stored with the data to aid in re-constructing an analytical sequence. Where an analysis is performed without an instrument, bound logbooks or bench sheets are used to record and file data. Standard and reagent information is recorded in logbooks or entered into LIMS for each method as required.
- Changes to hardcopy records must follow the procedures outlined in Sections 12 and 19. Changes to electronic records in LIMS or instrument data are recorded in audit trails.
- The reason for a signature or initials on a document is clearly indicated in the records such as "Sampled by," "Prepared by," "Reviewed by", or "Analyzed by".
- All generated data except those that are generated by automated data collection systems, are recorded directly, promptly and legibly in permanent dark ink.
- Hard-copy data may be scanned into PDF format for record storage as long as the scanning process can be verified in order to ensure no data is lost, and the data files and storage media must be tested to verify the laboratory's ability to retrieve the information prior to the destruction of the hard-copy which was scanned.

- Also refer to Section 19.14.1, "Computer and Electronic Data Related Requirements".

14.2 TECHNICAL AND ANALYTICAL RECORDS

14.2.1 The laboratory retains records of original observations, derived data and sufficient information to establish an audit trail, calibration records, staff records and a copy of each analytical report issued, for a minimum of five years unless otherwise specified by a client or regulatory requirement (refer to Section 15.1). The records for each analysis must contain sufficient information to enable the analysis to be repeated under conditions as close as possible to the original. The records must include the identity of laboratory personnel responsible for sample preparation, performance of each analysis and reviewing results.

14.2.2 Observations, data, and calculations are recorded in real-time at the time they are made and are identifiable to the specific task.

14.2.3 Changes to hardcopy records must follow the procedures outlined in Sections 12 and 19. Changes to electronic records in LIMS or instrument data are recorded in audit trails. The essential information to be associated with analysis, such as strip charts, tabular printouts, computer data files, analytical notebooks, and run logs, include:

- Laboratory sample ID code
- Date of analysis. Time of analysis is also required if the holding time is 72 hours or less, or when time-critical steps are included in the analysis (e.g., drying times, incubations, etc.); instrumental analyses have the date and time of analysis recorded as part of their general operations. Where a time critical step exists in an analysis, location for such a time is included as part of the documentation in a specific logbook or on a benchsheet.
- Instrumentation identification and instrument operating conditions/parameters. Operating conditions/parameters are typically recorded in instrument maintenance logs where available. Instrument logs may be in electronic format.
- Analysis type
- All manual calculations and manual integrations
- Analyst or operator initials/signature
- Sample preparation, including cleanup, separation protocols, incubation periods or subculture, ID codes, volumes, weights, instrument printouts, meter readings, calculations, reagents
- Test results
- Standard and reagent origin, receipt, preparation, and use
- Calibration criteria, frequency, and acceptance criteria
- Data and statistical calculations, review, confirmation, interpretation, assessment and reporting conventions
- Quality control protocols and assessment
- Electronic data security, software documentation and verification, software and hardware audits, backups, and records of any changes to automated data entries

- Method performance criteria including expected quality control requirements. These are indicated both in the LIMS and on specific analytical report formats.

14.3 LABORATORY SUPPORT ACTIVITIES

In addition to documenting all the above-mentioned activities, the following are retained QA records and project records (previous discussions in this section relate where and how these data are stored):

- All original raw data, whether hard-copy or electronic, for calibrations, samples and quality control measures, including analysts' work sheets and data output records (chromatograms, strip charts, and other instrument response readout records)
- A written description or reference to the specific test method used which includes a description of the specific computational steps used to translate parametric observations into a reportable analytical value
- Copies of final reports
- Archived SOPs
- Correspondence relating to laboratory activities for a specific project
- All Corrective Action reports, audits and audit responses
- Proficiency test results and raw data
- Results of data review, verification, and cross-checking procedures

14.3.1 Sample Handling Records

Records of all procedures to which a sample is subjected while in the possession of the laboratory are maintained. These include, but are not limited to, records pertaining to:

- Sample preservation including appropriateness of sample container and compliance with holding time requirement
- Sample identification, receipt, acceptance or rejection and login
- Sample storage and tracking including shipping receipts, sample transmittal / COC forms
- Procedures for the receipt and retention of samples, including all provisions necessary to protect the integrity of samples.

14.4 ADMINISTRATIVE RECORDS

The laboratory also maintains the administrative records in either electronic or hard-copy form. Refer to Table 14-1.

14.5 RECORDS MANAGEMENT, STORAGE AND DISPOSAL

14.5.1 All records (including those pertaining to test equipment), certificates, and reports are safely stored, held secure, and in confidence to the client. Certification-related records are

available to the accrediting body upon request.

14.5.2 All information necessary for the historical reconstruction of data is maintained by the laboratory. Records that are stored only on electronic media must be supported by the hardware and software necessary for their retrieval.

14.5.3 Records that are stored or generated by computers or personal computers have hardcopy, write-protected backup copies, or an electronic audit trail controlling access.

14.5.4 The laboratory has a record management system for control of laboratory notebooks, instrument logbooks, standards logbooks, and records for data reduction, validation, storage, and reporting. Laboratory notebooks are issued on a per analysis basis, and are numbered sequentially.

14.5.5 Transfer of Ownership

In the event the laboratory transfers ownership or goes out of business, the laboratory shall ensure that the records are maintained or transferred according to client's instructions. Upon ownership transfer, record retention requirements shall be addressed in the ownership transfer agreement and the responsibility for maintaining archives is clearly established. In addition, in cases of bankruptcy, appropriate regulatory and state legal requirements concerning laboratory records must be followed. In the event of the closure of the laboratory, all records will revert to the control of the corporate headquarters. Should the entire company cease to exist, as much notice as possible will be given to clients and the accrediting bodies who have worked with the laboratory during the previous five years of such action.

14.5.6 Records Disposal

14.5.6.1 Records are removed from the archive and destroyed after five years, unless otherwise specified by a client or regulatory requirement. On a project-specific or program basis, clients may need to be notified prior to record destruction. Records are destroyed in a manner that ensures their confidentiality such as shredding, mutilation or incineration (refer to Tables 14-1 and 14-2).

14.5.6.2 Electronic copies of records must be destroyed by erasure or physically damaging off-line storage media so no records can be read.

14.5.6.3 If a third party records management company is hired to dispose of records, a "Certificate of Destruction" is required.

SECTION 15

AUDITS (NELAC 5.4.13)

15.1 INTERNAL AUDITS

Internal audits are performed to verify that laboratory operations comply with the requirements of the lab's quality system and with the external quality programs under which the laboratory operates. Audits are planned and organized by the QA staff. Personnel conducting the audits should be independent of the area being evaluated. Auditors will have sufficient authority, access to work areas, and organizational freedom necessary to observe all activities affecting quality and to report the assessments to laboratory management and when requested to corporate management.

Audits are conducted and documented as described in TestAmerica Corporate SOP CA-Q-S-004 on performing Internal Audits. The types and frequency of routine internal audits are shown in Table 16-1. Special or ad hoc assessments may be conducted as needed under the direction of the QA staff.

Table 15-1. Types of Internal Audits and Frequency

Description	Performed by	Frequency
Quality Systems	QA Department or Designee	All areas of the laboratory annually
QA Technical Audits <ul style="list-style-type: none">- Evaluate raw data vs. final reports- Analyst integrity- Data authenticity	QA Department or Designee	All methods within a 2-year period, with at least 15% of methods every quarter
SOP Method Compliance	Group Leader	<ul style="list-style-type: none">- All SOPs within a 2-year period- All new analysts or new analyst/methods within 3 months of IDOC
Special	QA Department or Designee	Surveillance or spot checks performed as needed
Performance Testing	Analysts with QA oversight	Two successful per year for each NELAC field of testing or as dictated by regulatory requirements

15.1.1 Annual Quality Systems Audit

An annual quality systems audit is required to ensure compliance to analytical methods and SOPs, laboratory Data Integrity and Ethics Policies, NELAC quality systems, client and state

requirements, and the effectiveness of the internal controls of the analytical process, including but not limited to, data review, quality controls, preventive action, and corrective action. The completeness of earlier corrective action is assessed. The audit is divided into modules for each operating or support area of the lab, and each module is comprehensive for a given area. The area audits may be done on a rotating schedule throughout the year to ensure adequate coverage of all areas. This schedule may change as situations in the laboratory warrant.

Note: Part of the quality systems audit relates to regulatory compliance. An assessment of the laboratory's compliance to regulatory requirements is performed by Corporate QA through monthly management reports, review of client and regulatory concerns and also through periodic on-site evaluations.

15.1.2 QA Technical Audits

QA technical audits are based on client projects, associated sample delivery groups, and the methods performed. Reported results are compared to raw data to verify the authenticity of results. The validity of calibrations and QC results are compared to data qualifiers, footnotes, and case narratives. Documentation is assessed by examining run logs and records of manual integrations. Manual calculations are checked. Where possible, MintMiner is used to identify unusual manipulations of the data deserving closer scrutiny. QA technical audits must include all methods within a two-year period.

15.1.3 SOP Method Compliance

Compliance of all SOPs with the source methods and compliance of the operational groups with the SOPs must be assessed by the Technical Director and the QA department at least every two years. The work of each newly hired analyst is assessed within three months of working independently, (e.g., completion of method IDOC). In addition, as analysts add methods to their capabilities, (new IDOC) reviews of the analyst work products must be performed within 3 months of completing the documented training.

15.1.4 Special Audits

Special audits are conducted on an as needed basis, generally as a follow up to specific issues such as client complaints, corrective actions, PT results, data audits, system audits, validation comments, regulatory audits or suspected ethical improprieties. Special audits are focused on a specific issue, and report format, distribution, and timeframes are designed to address the nature of the issue.

15.1.5 Performance Testing

The laboratory participates semi-annually in performance audits conducted through the analysis of PT samples provided by a third party. The laboratory generally participates in the following types of PT studies--nonpotable water and soil

It is TestAmerica's policy that PT samples be treated as typical samples in the production process. Furthermore, where PT samples present special or unique problems, in the regular production process they may need to be treated differently, as would any special or unique

request submitted by any client. The QA Manager must be consulted and in agreement with any decisions made to treat a PT sample differently due to some special circumstance.

Written responses to unacceptable PT results are required. In some cases it may be necessary for blind QC samples to be submitted to the laboratory to show a return to control.

15.2 EXTERNAL AUDITS

External audits are performed when certifying agencies or clients conduct on-site inspections or submit performance testing samples for analysis. It is TestAmerica's policy to cooperate fully with regulatory authorities and clients. The laboratory makes every effort to provide the auditors with access to personnel, documentation, and assistance. Laboratory group leaders are responsible for providing corrective actions to the QA Manager who coordinates the response for any deficiencies discovered during an external audit. Audit responses are due in the time allotted by the client or agency performing the audit. A copy of the audit report and the laboratory's Corrective Action plan must be forwarded to Corporate Quality.

The laboratory cooperates with clients and their representatives to monitor the laboratory's performance in relation to work performed for the client. The client may only view data and systems related directly to the client's work. All efforts are made to keep other client information confidential.

15.2.1 Confidential Business Information (CBI) Considerations

During on-site audits, auditors may come into possession of information claimed as business confidential. A business confidentiality claim is defined as "a claim or allegation that business information is entitled to confidential treatment for reasons of business confidentiality or a request for a determination that such information is entitled to such treatment." When information is claimed as business confidential, the laboratory must place on (or attach to) the information at the time it is submitted to the auditor, a cover sheet, stamped or typed legend or other suitable form of notice, employing language such as "trade secret", "proprietary" or "company confidential". Confidential portions of documents otherwise non-confidential must be clearly identified. CBI may be purged of references to client identity by the responsible laboratory official at the time of removal from the laboratory. However, sample identifiers may not be obscured from the information. Additional information regarding CBI can be found in within the 2003 NELAC standards.

15.3 AUDIT FINDINGS

Audit findings are documented using the Corrective Action process and database. The laboratory's Corrective Action responses for both types of audits may include action plans that could not be completed within a predefined timeframe. In these instances, a completion date must set and agreed to by Operations management and the QA Manager.

Developing and implementing Corrective Action to findings is the responsibility of the Department Manager where the finding originated. Findings that are not corrected by specified due dates are reported monthly to management in the QA monthly report. A copy of the audit report and the laboratory's Corrective Action plan must be forwarded to Corporate Quality.

If any audit finding casts doubt on the effectiveness of the operations or on the correctness or validity of the laboratory's test results, the laboratory must take timely corrective action, and must notify clients in writing if the investigations show that the laboratory results have been affected. Once corrective action is implemented, a follow-up audit is scheduled to ensure that the problem has been corrected.

Clients must be notified promptly in writing, of any event such as the identification of defective measuring or test equipment that casts doubt on the validity of results given in any test report or amendment to a test report. The investigation must begin within 24 hours of discovery of the problem and all efforts are made to notify the client within two weeks after the completion of the investigation.

SECTION 16

MANAGEMENT REVIEWS (NELAC 5.4.14)

16.1 QUALITY ASSURANCE REPORT

A comprehensive QA Report must be prepared each month by the laboratory's QA Department and forwarded to the Laboratory Director/Manager and their Corporate Quality Director as well as the General Manager. All aspects of the QA system are reviewed to evaluate the suitability of policies and procedures. During the course of the year, the Laboratory Director/Manager, General Manager, or Corporate QA may request that additional information be added to the report.

On a monthly basis, Corporate QA compiles information from all the monthly laboratory reports. The Corporate Quality Directors prepare a report that includes a compilation of all metrics and notable information and concerns regarding the QA programs within the laboratories. The report also includes a listing of new regulations that may potentially impact the laboratories. This report is presented to the Senior Management Team and General Managers.

16.2 ANNUAL MANAGEMENT REVIEW

The Senior Lab Management Team (Laboratory Director, Technical Director, Operations Manager, QA Manager, HR Supervisor, I.T. Supervisor) conducts a review annually of its quality systems and LIMS to ensure its continuing suitability and effectiveness in meeting client and regulatory requirements and to introduce any necessary changes or improvements. It will also provide a platform for defining quality goals and objectives. Corporate Operations and Corporate QA personnel may be included in this meeting at the discretion of the Laboratory Director/Manager. The LIMS review consists of examining any audits, complaints or concerns that have been raised through the year that are related to the LIMS. The laboratory must summarize any critical findings that cannot be solved by the lab, and report them to Corporate IT.

The Management Systems Review (Corporate SOP CA-Q-S-008 and Work Instruction CA-Q-WI-020) uses information generated during the preceding year to assess the "big picture" by ensuring that routine actions taken and reviewed on a monthly basis are not components of larger systematic concerns. The monthly review should keep the quality systems current and effective; therefore, the annual review is a formal senior management process to review specific existing documentation. Significant issues from the following documentation are compiled or summarized by the QA Manager prior to the review meeting:

- Matters arising from the previous annual review
- Prior Monthly QA Reports issues
- Laboratory QA Metrics
- Review of report reissue requests
- Review of client feedback and complaints

- Issues arising from any prior management or staff meetings
- Minutes from prior Senior Lab Management Team meetings. Issues that may be raised from these meetings include:
 - Adequacy of staff, equipment and facility resources
 - Adequacy of policies and procedures
 - Future plans for resources and testing capability and capacity
- The annual internal double blind PT program sample performance (if performed)
- Compliance to the Ethics Policy and Data Integrity Plan, including any evidence/incidents of inappropriate actions or vulnerabilities related to data Integrity

A report is generated by the QA Manager and management. The report is distributed to the appropriate General Manager and Corporate Quality Director. The report includes, but is not limited to:

- The date of the review and the names and titles of participants
- A reference to the existing data quality related documents and topics that were reviewed
- Quality system or operational changes or improvements that will be made as a result of the review, e.g., an implementation schedule including assigned responsibilities for the changes (Action Table)

Changes to the quality systems requiring update to the laboratory QA Manual must be included in the next revision of the QA Manual.

16.3 POTENTIAL INTEGRITY RELATED MANAGERIAL REVIEWS

Potential integrity issues (data or business related) must be handled and reviewed in a confidential manner until such time as a follow-up evaluation, full investigation, or other appropriate actions have been completed and issues clarified. TestAmerica's Corporate Data Investigation/ Recall SOP CA-L-S-001 must be followed. All investigations that result in finding inappropriate activity are documented and include any disciplinary actions involved, corrective actions taken, and all appropriate notifications of clients.

TestAmerica's COO, VP of Client & Technical Services, General Managers and Corporate Quality Directors receive a monthly report from the Director of Quality & Client Advocacy summarizing any current data integrity or data recall investigations. The General Managers are also made aware of progress on these issues for their specific labs.

SECTION 17

PERSONNEL (NELAC 5.5.2)

17.1 OVERVIEW

The laboratory's management believes that its highly qualified and professional staff is the single most important aspect in assuring a high level of data quality and service. The staff consists of professionals and support personnel as outlined in the organization chart in Figure 4-1.

All personnel must demonstrate competence in the areas where they have responsibility. Any staff that is undergoing training must have appropriate supervision until they have demonstrated their ability to perform their job function on their own. Staff must be qualified for their tasks based on appropriate education, training, experience and/or demonstrated skills as required.

The laboratory employs sufficient personnel with the necessary education, training, technical knowledge and experience for their assigned responsibilities.

All personnel are responsible for complying with all QA/QC requirements that pertain to the laboratory and their area of responsibility. Each staff member must have a combination of experience and education to adequately demonstrate a specific knowledge of their particular area of responsibility. Technical staff must also have a general knowledge of lab operations, test methods, QA/QC procedures and records management.

Laboratory management is responsible for formulating goals for lab staff with respect to education, training and skills and ensuring that the laboratory has a policy and procedures for identifying training needs and providing training of personnel. The training must be relevant to the present and anticipated responsibilities of the lab staff.

The laboratory only uses personnel that are employed by or under contract to, the laboratory. Contracted personnel, when used, must meet competency standards of the laboratory and work in accordance to the laboratory's quality system.

17.2 EDUCATION AND EXPERIENCE REQUIREMENTS FOR TECHNICAL PERSONNEL

The laboratory makes every effort to hire analytical staff that possess a college degree (AA, BA, BS) in an applied science with some chemistry in the curriculum. Exceptions can be made based upon the individual's experience and ability to learn. There are competent analysts and technicians in the industry who have not earned a college degree. Selection of qualified candidates for laboratory employment begins with documentation of minimum education, training, and experience prerequisites needed to perform the prescribed task. Minimum education and training requirements for TestAmerica employees are outlined in job descriptions and are generally summarized for analytical staff in the table below.

The laboratory maintains job descriptions for all personnel who manage, perform or verify work affecting the quality of the environmental testing the laboratory performs. Job Descriptions are located on the TestAmerica intranet "Human Resources" web-page (also see Section 4 for position descriptions/responsibilities).

Experience and specialized training are occasionally accepted in lieu of a college degree (basic lab skills such as using a balance, colony counting, aseptic or quantitation techniques, etc. are also considered

As a general rule for analytical staff:

Specialty	Education	Experience
Extractions, Digestions, some electrode methods (pH, DO, Redox, etc.), or Titrimetric and Gravimetric Analyses	H.S. Diploma	On the job training (OJT)
CVAA, FLAA, Single component or short list Chromatography (e.g., Fuels, BTEX-GC, IC	A college degree in an applied science or 2 years of college and at least one year of college chemistry	Or 2 years prior analytical experience is required
ICP, ICPMS, Long List or complex chromatography (e.g., Pesticides, PCB, Herbicides, HPLC, etc.), GCMS	A college degree in an applied science or 2 years of college chemistry	Or 5 years of prior analytical experience
Spectra Interpretation	A college degree in an applied science or 2 years of college chemistry	And 2 years relevant experience. Or 5 years of prior analytical experience
Technical Directors/Department Managers – <u>General</u>	Bachelors Degree in an applied science or engineering with 24 semester hours in chemistry An advanced (MS, PhD.) degree may substitute for one year of experience	And 2 years experience in environmental analysis of representative analytes for which they will oversee
Technical Director – <u>Wet Chem</u> only (no advanced instrumentation)	Associate degree in an applied science or engineering or 2 years of college with 16 semester hours in chemistry	And 2 years relevant experience

When an analyst does not meet these requirements, they can perform a task under the direct supervision of a qualified analyst, peer reviewer or Department Manager, and are considered an analyst in training. The person supervising an analyst in training is accountable for the quality of the analytical data and must review and approve data and associated corrective actions.

17.3 TRAINING

The laboratory is committed to furthering the professional and technical development of employees at all levels.

Orientation to the laboratory's policies and procedures, in-house method training, and employee attendance at outside training courses and conferences all contribute toward employee proficiency. Below are examples of various areas of required employee training:

Required Training	Time Frame*	Employee Type
New Hire Orientation	Immediately	All
Environmental Health & Safety Orientation	Prior to lab work	All
Environmental Health & Safety Orientation Follow-up Test	30-60 days after hire	All
Environmental Health & Safety Training	Refer to EH&S Manual	All
Ethics – New Hires	1 week of hire	All
Ethics - Comprehensive	90 days of hire	All
Data Integrity	30 days of hire	Technical and PMs
Quality Assurance	90 days of hire	All
Ethics – Comprehensive Refresher	Annually	All
Initial Demonstration of Capability (DOC)	Prior to unsupervised method performance	Technical

The laboratory maintains records of relevant authorization/competence, education, professional qualifications, training, skills and experience of technical personnel (including contracted personnel) as well as the date that approval/authorization was given. These records are kept on file at the laboratory. Also refer to "Demonstration of Capability" in Section 19.

The training of technical staff is kept up to date by:

- Each employee must have documentation in their training file that they have read, understood and agreed to follow the most recent version of the laboratory QA Manual and SOPs in their area of responsibility. This documentation is updated as SOPs are updated.
- Documentation from any training courses or workshops on specific equipment, analytical techniques or other relevant topics are maintained in the employee's training file.
- Documentation of proficiency (refer to Section 19)
- An Ethics Agreement signed by each staff member (renewed each year) and evidence of annual ethics training
- A Confidentiality Agreement signed by each staff member signed at the time of employment
- Human Resources maintains documentation and attestation forms on employment status & records; benefit programs; timekeeping/payroll; and employee conduct, e.g., ethics. This information is maintained in the employee's secured personnel file.

Evidence of successful training could include such items as:

- Adequate documentation of training within operational areas, including one-on-one technical training for individual technologies, and particularly for people cross-trained.
- Analysts' knowledge to refer to QA Manual for quality issues
- Analysts following SOPs, i.e., practice matches SOPs
- Analysts regularly communicate to group leaders and QA if SOPs need revision rather than waiting for auditors to find problems.

Further details of the laboratory's training program are described in the Laboratory Training SOP NC-QA-028, Employee Orientation and Training.

17.4 DATA INTEGRITY AND ETHICS TRAINING PROGRAM

Establishing and maintaining a high ethical standard is an important element of a Quality System. Ethics and data integrity training is integral to the success of TestAmerica and is provided for each employee at TestAmerica. It is a formal part of the initial employee orientation within one week of hire followed by technical data integrity training within 30 days, comprehensive training within 90 days, and annual refresher for all employees. Senior management at each facility performs the Ethics training for their staff.

In order to ensure that all personnel understand the importance TestAmerica places on maintaining high ethical standards at all times, TestAmerica has established a Corporate Ethics Policy (CA-L-P-001) and an Ethics Statement. All initial and annual training is documented by signature on the signed Ethics Statement/Agreement demonstrating that the employee has participated in the training and understands their obligations related to ethical behavior and data integrity.

Violations of this Ethics Policy will not be tolerated. Employees who violate this policy will be subject to disciplinary actions up to and including termination. Criminal violations may also be referred to the Government for prosecution. In addition, such actions could jeopardize TestAmerica's ability to do work on Government contracts; and for that reason, TestAmerica has a zero tolerance approach to such violations.

Employees are trained as to the legal and environmental repercussions that result from data misrepresentation. Key topics covered in the presentation include:

- Organizational mission and its relationship to the critical need for honesty and full disclosure in all analytical reporting
- Ethics Policy
- How and when to report ethical/data integrity issues. Confidential reporting.
- Record keeping
- Discussion regarding data integrity procedures

- Specific examples of breaches of ethical behavior--peak shaving, altering data or computer clocks, improper macros, etc., accepting/offering kickbacks, illegal accounting practices, unfair competition/collusion
- Internal monitoring. Investigations and data recalls
- Consequences for infractions including potential for immediate termination, debarment, or criminal prosecution
- Importance of proper written narration / data qualification by the analyst and project manager with respect to those cases where the data may still be usable but are in one sense or another partially deficient

Additionally, a Data Integrity Hotline (1-800-736-9407) is maintained by TestAmerica and administered by the Corporate Quality Department.

SECTION 18

ACCOMMODATIONS AND ENVIRONMENTAL CONDITIONS **(NELAC 5.5.3)**

18.1 OVERVIEW

The laboratory is an 54,440 sq. ft. secure laboratory facility with controlled access and designed to accommodate an efficient workflow and to provide a safe and comfortable work environment for employees. All visitors sign in and are escorted by laboratory personnel. Access is controlled by various measures.

The laboratory is equipped with structural safety features. Each employee is familiar with the location, use, and capabilities of general and specialized safety features associated with their workplace. The laboratory provides and requires the use of protective equipment including safety glasses, protective clothing, gloves, etc. OSHA and other regulatory agency guidelines regarding required amounts of bench and fume hood space, lighting, ventilation (temperature and humidity-controlled), access, and safety equipment are met or exceeded.

Traffic flow through sample preparation and analysis areas is minimized to reduce the likelihood of contamination. Adequate floor space and bench top area is provided to allow unencumbered sample preparation and analysis space. Sufficient space is also provided for storage of reagents and media, glassware, and portable equipment. Ample space is also provided for refrigerated sample storage before analysis and archival storage of samples after analysis. Laboratory HVAC and deionized water systems are designed to minimize potential trace contaminants.

The laboratory is separated into specific areas for sample receiving, sample preparation, volatile organic sample analysis, non-volatile organic sample analysis, inorganic sample analysis, and administrative functions.

18.2 ENVIRONMENT

Laboratory accommodation, test areas, energy sources, lighting are adequate to facilitate proper performance of tests. The facility is equipped with heating, ventilation, and air conditioning (HVAC) systems appropriate to the needs of environmental testing performed at this laboratory.

The environment in which these activities are undertaken does not invalidate the results or adversely affect the required accuracy of any measurements.

The laboratory provides for the effective monitoring, control and recording of environmental conditions that may affect the results of environmental tests as required by the relevant specifications, methods, and procedures. Such environmental conditions include humidity, voltage, temperature, and vibration levels in the laboratory. A 225KVA UPS is installed in the main electrical bus to provide at least 15 minutes of backup power in the event of a power failure. This unit also provides voltage and frequency control of lab and office power. A spike/surge arrestor is installed to protect against power surge/sag and lightning strikes. A 30 KW natural gas-fueled backup generator is installed to provide power to the I.T. area in the event of a power failure. Additionally, this generator provides power to two walk-in sample

storage coolers and several other smaller sample storage coolers. Smaller portable generators are available to provide “spot power” where needed in the event of a power failure.

When any of the method or regulatory required environmental conditions change to a point where they may adversely affect test results, analytical testing must be discontinued until the environmental conditions are returned to the required levels.

Environmental conditions of the facility housing the computer network and LIMS are regulated to protect against raw data loss.

18.3 WORK AREAS

There is effective separation between neighboring areas when the activities therein are incompatible with each other. Examples include:

- Volatile organic chemical handling areas, including sample preparation and waste disposal, and volatile organic chemical analysis areas.

Access to, and use of, all areas affecting the quality of analytical testing is defined and controlled by secure access to the laboratory building as described below in the Building Security section.

Adequate measures are taken to ensure good housekeeping in the laboratory and to ensure that any contamination does not adversely affect data quality. These measures include regular cleaning to control dirt and dust within the laboratory.

Work areas are available to ensure an unencumbered work area. Work areas include:

- Access and entryways to the laboratory
- Sample receipt areas
- Sample storage areas
- Chemical and waste storage areas
- Data handling and storage areas
- Sample processing areas
- Sample analysis areas

18.4 FLOOR PLAN

A floor plan can be found in Appendix 1.

18.5 BUILDING SECURITY

Building keys are distributed to employees as necessary.

Visitors to the laboratory sign in and out in a visitor’s logbook. A visitor is defined as any person who visits the laboratory who is not an employee of the laboratory. In addition to signing into

the laboratory, the Environmental, Health and Safety Manual contains requirements for visitors and vendors. There are specific safety forms that must be reviewed and signed.

Visitors (with the exception of company employees) are escorted by laboratory personnel at all times, or the location of the visitor is noted in the visitor's logbook.

Signs are posted in the laboratory designating employee only areas - "Authorized employees beyond this point".

SECTION 19

TEST METHODS AND METHOD VALIDATION (NELAC 5.5.4)

19.1 OVERVIEW

The laboratory uses methods that are appropriate to meet our clients' requirements and that are within the scope of the laboratory's capabilities. These include sampling, handling, transport, storage and preparation of samples; and where appropriate, an estimation of the measurement of uncertainty as well as statistical techniques for analysis of environmental data.

Instructions are available in the laboratory for the operation of equipment as well as for the handling and preparation of samples. All instructions, Standard Operating Procedures (SOPs), reference methods and manuals relevant to the working of the laboratory are readily available to all staff. Deviations from published methods are documented (with justification) in the laboratory's approved SOPs. SOPs are submitted to clients for review at their request. Significant deviations from published methods require client approval and regulatory approval where applicable.

19.2 STANDARD OPERATING PROCEDURES (SOPs)

The laboratory maintains SOPs that accurately reflect all phases of the laboratory such as assessing data integrity, corrective actions, handling customer complaints as well as all analytical methods and sampling procedures. The method SOPs are derived from the most recently promulgated/approved, published methods and are specifically adapted to the laboratory facility. Modifications or clarifications to published methods are clearly noted in the SOPs. All SOPs are controlled in the laboratory.

- All SOPs contain a revision number, effective date, and appropriate approval signatures. Controlled copies are available to all staff.
- Procedures for writing an SOP are incorporated by reference to TestAmerica's Corporate SOP CW-Q-S-002 entitled Writing a Standard Operating Procedure, or the laboratory's SOP NC-QA-027, Preparation and Management of Standard Operating Procedures.
- SOPs are reviewed at a minimum of every two years (annually for Drinking Water and DoD SOPs), and where necessary, revised to ensure continuing suitability and compliance with applicable requirements.

19.3 LABORATORY METHODS MANUAL

For each test method, the laboratory must have available the published referenced method as well as the laboratory developed SOP.

Note: If more stringent standards or requirements are included in a mandated test method or regulation than those specified in this manual, the laboratory must demonstrate that such requirements are met. If it is not clear which requirements are more stringent, the standard from the method or regulation is to be followed. Any exceptions or deviations from the referenced methods or regulations are noted in the specific analytical SOP.

The laboratory maintains an SOP Index for both technical and non-technical SOPs. Technical SOPs are maintained to describe a specific test method. Non-technical SOPs are maintained to describe functions and processes not related to a specific test method.

19.4 SELECTION OF METHODS

Since numerous methods and analytical techniques are available, continued communication between the client and laboratory is imperative to assure the correct methods are utilized. Once client methodology requirements are established, this and other pertinent information is summarized by the Project Manager. These mechanisms ensure that the proper analytical methods are applied when the samples arrive for log-in. For non-routine analytical services, e.g., special matrices, non-routine compound lists, etc., the method of choice is selected based on client needs and available technology. The methods selected should be capable of measuring the specific parameter of interest, in the concentration range of interest, and with the required precision and accuracy.

19.4.1 Sources of Methods

Routine analytical services are performed using standard EPA-approved methodology. In some cases, modification of standard approved methods may be necessary to provide accurate analyses of particularly complex matrices. When the use of specific methods for sample analysis is mandated through project or regulatory requirements, only those methods must be used.

When clients do not specify the method to be used or methods are not required, the methods used must be clearly validated and documented in an SOP and available to clients and/or the end user of the data.

The analytical methods used by the laboratory are those currently accepted and approved by the U. S. EPA and the state or territory from which the samples were collected. Reference methods include:

- Method 1664, Revision A: N-Hexane Extractable Material (HEM; Oil and Grease) and Silica Gel Treated N-Hexane Extractable Material (SGT-HEM); Non-polar Material) by Extraction and Gravimetry, EPA-821-R-98-002, February 1999
- Guidelines Establishing Test Procedures for the Analysis of Pollutants Under the Clean Water Act, and Appendix A-C; 40 CFR Part 136, USEPA Office of Water. Revised as of July 1, 1995, Appendix A to Part 136 - Methods for Organic Chemical Analysis of Municipal and Industrial Wastewater (EPA 600 Series)
- Methods for Chemical Analysis of Water and Wastes, EPA 600 (4-79-020), 1983.
- Methods for the Determination of Inorganic Substances in Environmental Samples, EPA-600/R-93/100, August 1993.
- Methods for the Determination of Metals in Environmental Samples, EPA/600/4-91/010, June 1991. Supplement I: EPA-600/R-94/111, May 1994.
- Standard Methods for the Examination of Water and Wastewater, 18th/19th/20th edition/ on-line edition Eaton, A.D. Clesceri, L.S. Greenberg, A.E. Eds; American Water Works Association, Water Pollution Control Federation, American Public Health Association: Washington, D.C.

- Test Methods for Evaluating Solid Waste Physical/Chemical Methods (SW846), Third Edition, September 1986, Final Update I, July 1992, Final Update IIA, August 1993, Final Update II, September 1994; Final Update IIB, January 1995; Final Update III, December 1996.
- Annual Book of ASTM Standards, American Society for Testing & Materials (ASTM), Philadelphia, PA.
- Code of Federal Regulations (CFR) 40, Parts 136, 141, 172, 173, 178, 179 and 261

TABLE 19-1. Wet Chemistry Methods¹

Analytical Parameters	Matrix	Fields of Testing			
			CWA	RCRA (SW846)	Other
Acidity	Water		305. ² SM 2310 B	--	--
Alkalinity, Bicarbonate, Carbonate	Water		305. ² SM 2320 B		
	Solid		EPA 310.1 ² (M)	--	--
Arsenic (ASV) Anodic Stripping Voltammetry	Water		--	EPA 7063	--
Ash Content	Solid		--	--	ASTM D29-74
Biochemical Oxygen Demand, Carbonaceous	Water		EPA 405.1 SM 5210 B	--	--
Bromide	Water		EPA 300.0A	EPA 9056A	--
	Waste		EPA 300.0A	EPA 9056A	--
	Solid		EPA 300.0A (M)	EPA 9056A	--
Cation-Exchange Capacity	Solid		--	EPA 9081	--
Chemical Oxygen Demand	Water		EPA 410.4 SM 5220D	--	--
	Waste		EPA 410.4	--	--
Chloride	Water		EPA 300.0A EPA 325.2 ²	EPA 9056A EPA 9251	EPA 325.2 ²
	Waste		EPA 300.0A	EPA 9056A	--
	Solid		EPA 300.0A (M)	EPA 9056A EPA 9251(M)	--
Chromium, Hexavalent	Water		EPA 3500-Cr-D	EPA 7196A	--
	Waste		EPA 3500-Cr-D	EPA 7196A	--

Analytical Parameters	Matrix	Fields of Testing			
			CWA	RCRA (SW846)	Other
	Solid		--	EPA 3060A EPA 7196A	--
Specific Conductance	Water		EPA 120.1 SM 2510B	EPA 9050A	--
	Waste		EPA 120.1	EPA 9050A	--
	Solid		--	EPA 9050A	--
Chlorine, Residual	Water		EPA 330.5 ² SM 3500 CL-G	--	--
Cyanide (Amenable)	Water		EPA 335.1 ² SM 4500 CN-G	EPA 9012A	--
	Solid		--	EPA 9012A	--
Cyanide (Total)	Water		SM 4500-CN E EPA 335.4 335.2-CLP-M	EPA 9012A	---
	Waste		--	EPA 9012A	--
	Solid		335.2-CLP-M	EPA 9012A	--
Cyanide (Weak and Dissociable) (Free)	Water		SM 4500-CN I	--	--
Dissolved Oxygen	Water		360.1 ² SM 4500 O-G	--	--
Flash Point	Waste		--	EPA 1010	ASTM D93-9
	Solid		--	EPA 1010	ASTM D93-9
Fluoride	Water		EPA 300.0A EPA 340.2 ²	EPA 9056A	SM 4500 F-C, ISE
	Waste		EPA 340.2 (M) ² EPA 300.0A (M)	EPA 9056A	--
	Solid		EPA 340.2 (M) ² EPA 300.0A (M)	EPA 9056A	--
Iron, Ferrous & Ferric	Water		SM 3500 FE D	--	--
Hardness	Water		EPA 130.2 ²	--	SM 2340B
Moisture	Solid		---	EPA 160.3 (M) ASTM D2216-90	---
Nitrogen, Ammonia	Water		EPA 350.1	--	EPA 350.2 ²
	Waste		EPA 350.1	--	EPA 350.2 ²
	Solid		EPA 350.1	--	EPA 350.2 ²
	Water		SM 4500 NH ₃ -E (Titration)	--	--

Analytical Parameters Matrix	Matrix	Fields of Testing			
			CWA	RCRA (SW846)	Other
Nitrogen, Ammonia (cont'd)	Water		SM 4500 NH ₃ -F (ISE)	--	--
Nitrite (NO ₂)	Water		EPA 300.0A	EPA 9056A	--
	Waste		EPA 300.0A (M)	EPA 9056A	--
	Solid		EPA 300.0A (M)	EPA 9056A	--
Nitrate (NO ₃)	Water		EPA 300.0A	EPA 9056A	SM 4500 NO ₃ -E
	Waste		EPA 300.0A (M)	EPA 9056A	--
	Solid		EPA 300.0A (M)	--	--
Nitrate plus Nitrite NO ₂ /NO ₃	Water		EPA 353.2	--	--
	Waste		EPA 353.2	--	--
Total Kjeldahl Nitrogen (TKN)	Water		EPA 351.3	--	SM 4500 NO ₃
	Waste		EPA 351.3	--	--
	Solid		EPA 351.3	--	--
Oil and Grease (Hexane Extractable Material)	Water		EPA 1664A	EPA 9071B	--
	Waste		EPA 1664A	EPA 9071B	--
	Solid		--	EPA 9071B	--
Ortho-phosphate o-PO ₄	Water		EPA 300.0A EPA 365.1	EPA 9056A	SM 4500 P-E
	Waste		EPA 300.0A (M)	EPA 9056A	--
	Solid		EPA 300.0A (M) EPA 365.1	EPA 9056A	--
pH	Water		EPA 150.1 ²	EPA 9040B	EPA 9041
	Waste		SM 4500 H-B	EPA 9045C	--
	Solid		---	EPA 9045C	--
Paint Filter	Water		--	EPA 9095A	--
Phenolics	Water		EPA 420.1	--	--
	Waste		--	EPA 9065	--
	Solid		--	EPA 9065	--
Phosphorus (Total)	Water		EPA 365.1	--	SM 4500 P-E
	Waste		EPA 365.1	--	--
	Solid		EPA 365.1	--	--
Sulfate (SO ₄)	Water		EPA 300.0A EPA 375.4 ²	EPA 9056A EPA 9038	--
	Waste		EPA 300.0A (M) EPA 375.4 ²	EPA 9056A EPA 9038	--
	Solid		EPA 300.0A (M)	EPA 9056A EPA 9038 (M)	--

Analytical Parameters	Matrix	Fields of Testing			
			CWA	RCRA	Other
Sulfide	Water		EPA 376.1 ²	EPA 9030A SM 4500	9030B/9034
Total Organic Carbon (TOC)	Water		EPA 415.1 ²	EPA 9060	SM 5310 D
	Waste		--	EPA 9060	--
	Solid		EPA 415.1 (M)	EPA 9060 (M)	Walkley-Black
Total Organic Halides (TOX)	Water		--	EPA 9020B EPA 9023(EOX)	EPA 450.1
	Waste		--	--	--
	Solid		--	EPA 9020B	--
Total Petroleum Hydrocarbons	Water		EPA 1664A (SGT-HEM)	EPA 9071B	--
	Waste		EPA 1664A (SGT-HEM)	EPA 9071B	--
	Solid		--	EPA 9071B	--
Total Solids	Water		EPA 160.3	--	--
	Waste		EPA 160.3	--	--
	Solid		EPA 160.3 (M)	--	--
Total Dissolved Solids	Water		EPA 160.1	--	2540E
Total Suspended Solids	Water		EPA 160.2	---	2540E
Volatile and Volatile Suspended Solids	Water		EPA 160.4	--	--
Settleable Solids	Water		EPA 160.5	--	--
Turbidity	Water		EPA 180.1	--	--

¹ Any matrix not listed is not applicable for the associated method

² Removed from 40CFR

TABLE 19-2. Methods for Mercury by Cold Vapor Atomic Absorption

Analytical Parameters	Matrix	Fields of Testing			
			CWA	RCRA (SW846)	Other
Mercury (CVAA)	Water		EPA 245.1	EPA 7470A	--
	TCLP Leachate		--	EPA 7470A	--
	Waste		--	EPA 7471A	--
	Solid		EPA 254.5	EPA 7471A	--

TABLE 19-3. Methods for Mercury by Cold Vapor Atomic Fluorescence

Analytical Parameters	Matrix	Fields of Testing			
			CWA	RCRA (SW846)	Other
Mercury, Low Level (CVAFS)	Water		--	--	EPA 1631E

TABLE 19-4. Methods for Metals by ICP and ICPMS

Analytical Parameters	Matrix	Fields of Testing			
			CWA	RCRA (SW846)	Other
Aluminum	Water		EPA 200.7 EPA 200.8	EPA 6010B EPA 6020	---
	Waste		---	EPA 6010B EPA 6020	---
	Solid		EPA 200.7 EPA 200.8	EPA 6010B EPA 6020	---
Antimony	Water		EPA 200.7 EPA 200.8	EPA 6010B EPA 6020	---
	Waste		---	EPA 6010B EPA 6020	---
	Solid		EPA 200.7 EPA 200.8	EPA 6010B EPA 6020	---
Arsenic	Water		EPA 200.7 EPA 200.8	EPA 6010B EPA 6020	---
	Waste		---	EPA 6010B EPA 6020	---
	Solid		EPA 200.7 EPA 200.8	EPA 6010B EPA 6020	---

Analytical Parameters	Matrix	Fields of Testing			
			CWA	RCRA (SW846)	Other
Barium	Water		EPA 200.7 EPA 200.8	EPA 6010B EPA 6020	---
	Waste		---	EPA 6010B EPA 6020	---
	Solid		EPA 200.7 EPA 200.8	EPA 6010B EPA 6020	---
Beryllium	Water		EPA 200.7 EPA 200.8	EPA 6010B EPA 6020	---
	Waste		---	EPA 6010B EPA 6020	---
	Solid		EPA 200.7 EPA 200.8	EPA 6010B EPA 6020	---
Boron	Water		EPA 200.7	EPA 6010B	---
	Waste		---	EPA 6010B	---
	Solid		EPA 200.7	EPA 6010B	---
Calcium	Water		EPA 200.7	EPA 6010B	---
	Waste		---	EPA 6010B	---
	Solid		EPA 200.7	EPA 6010B	---
Cadmium	Water		EPA 200.7 EPA 200.8	EPA 6010B EPA 6020	---
	Waste		---	EPA 6010B EPA 6020	---
	Solid		EPA 200.7 EPA 200.8	EPA 6010B EPA 6020	---
Cobalt	Water		EPA 200.7 EPA 200.8	EPA 6010B EPA 6020	---
	Waste		---	EPA 6010B EPA 6020	---
	Solid		EPA 200.7 EPA 200.8	EPA 6010B EPA 6020	---
Chromium	Water		EPA 200.7 EPA 200.8	EPA 6010B EPA 6020	---
	Waste		---	EPA 6010B EPA 6020	---
	Solid		EPA 200.7 EPA 200.8	EPA 6010B EPA 6020	---
Copper	Water		EPA 200.7 EPA 200.8	EPA 6010B EPA 6020	---
	Waste		---	EPA 6010B EPA 6020	---
	Solid		EPA 200.7 EPA 200.8	EPA 6010B EPA 6020	---

Analytical Parameters	Matrix	Fields of Testing			
			CWA	RCRA (SW846)	Other
Iron	Water		EPA 200.7 EPA 200.8	EPA 6010B EPA 6020	
	Waste		---	EPA 6010B EPA 6020	---
	Solid		EPA 200.7 EPA 200.8	EPA 6010B EPA 6020	---
Lead	Water		EPA 200.7 EPA 200.8	EPA 6010B EPA 6020	---
	Waste		---	EPA 6010B EPA 6020	---
	Solid		EPA 200.7 EPA 200.8	EPA 6010B EPA 6020	---
Magnesium	Water		EPA 200.7	EPA 6010B EPA 6020	---
	Waste		---	EPA 6010B EPA 6020	---
	Solid		EPA 200.7	EPA 6010B EPA 6020	---
Manganese	Water		EPA 200.7 EPA 200.8	EPA 6010B EPA 6020	---
	Waste		---	EPA 6010B EPA 6020	---
	Solid		EPA 200.7 EPA 200.8	EPA 6010B EPA 6020	---
Molybdenum	Water		EPA 200.7 EPA 200.8	EPA 6010B EPA 6020	---
	Waste		---	EPA 6010B EPA 6020	---
	Solid		EPA 200.7 EPA 200.8	EPA 6010B EPA 6020	---
Nickel	Water		EPA 200.7 EPA 200.8	EPA 6010B EPA 6020	---
	Waste		---	EPA 6010B EPA 6020	---
	Solid		EPA 200.7 EPA 200.8	EPA 6010B EPA 6020	---
Potassium	Water		EPA 200.7	EPA 6010B	---
	Waste		---	EPA 6010B	---
	Solid		---	EPA 6010B	---
Selenium	Water		EPA 200.7 EPA 200.8	EPA 6010B EPA 6020	---
	Waste		---	EPA 6010B EPA 6020	---
	Solid		EPA 200.7 EPA 200.8	EPA 6010B EPA 6020	---

Analytical Parameters	Matrix	Fields of Testing			
			CWA	RCRA (SW846)	Other
Silver	Water		EPA 200.7 EPA 200.8	EPA 6010B EPA 6020	---
	Waste		---	EPA 6010B EPA 6020	---
	Solid		EPA 200.7 EPA 200.8	EPA 6010B EPA 6020	---
Sodium	Water		EPA 200.7	EPA 6010B	---
	Waste		---	EPA 6010B	---
	Solid		---	EPA 6010B	---
Tin	Water		EPA 200.7 EPA 200.8	EPA 6010B EPA 6020	---
	Waste		---	EPA 6010B EPA 6020	---
	Solid		EPA 200.7 EPA 200.8	EPA 6010B EPA 6020	---
Thallium	Water		EPA 200.7 EPA 200.8	EPA 6010B EPA 6020	---
	Waste		---	EPA 6010B EPA 6020	---
	Solid		EPA 200.7 EPA 200.8	EPA 6010B EPA 6020	---
Titanium	Water		EPA 200.7	EPA 6010B	---
	Waste		---	EPA 6010B	---
	Solid		---	EPA 6010B	---
Vanadium	Water		EPA 200.7 EPA 200.8	EPA 6010B EPA 6020	---
	Waste		---	EPA 6010B EPA 6020	---
	Solid		---	EPA 6010B EPA 6020	---
Zinc	Water		EPA 200.7 EPA 200.8	EPA 6010B EPA 6020	---
	Waste		---	EPA 6010B EPA 6020	---
	Solid		EPA 200.7 EPA 200.8	EPA 6010B EPA 6020	---

TABLE 19-5. Metals Sample Preparation Methods

Analytical Parameters	Matrix	Fields of Testing			
			CWA	RCRA (SW846)	Other
Toxicity Characteristic Leaching Procedure (TCLP)	Water		---	EPA 1311	---
	Waste		---	EPA 1311	---
	Solid		---	EPA 1311	---
ICP Metals	Water		EPA 200.7	EPA 3005A EPA 3010A	---
	TCLP Leachate		---	EPA 3010A	---
	Waste		---	EPA 3050B	---
	Solid		---	EPA 3050B	---
ICPMS Metals	Water		EPA 200.8	EPA 3010A	---
	TCLP		---	EPA 3010A	---
	Waste		---	EPA 3050B	---
	Solid		---	EPA 3050B	---
CVAA Mercury	Water		EPA 245.1	EPA 7470A	---
	TCLP Leachate		---	EPA 7470A	---
	Waste		---	EPA 7471A	---
	Solid		---	EPA 7471A	
CVAFS Mercury Low Level	Water		---	---	EPA 1631E

TABLE 19-6. Organic Sample Preparation Methods

Analytical Parameters	Matrix	Fields of Testing			
			CWA	RCRA (SW846)	Other
Volatiles by GC/MS	Water		EPA 624	EPA 5030B	---
	Waste		---	EPA 5030B EPA 5035	---
	Solid		---	EPA 5035 EPA 5035A	---
Halogenated Volatiles by GC	Water		EPA 601	EPA 5030B	---
	Waste		---	EPA 5030B EPA 5035	---
	Solid		---	EPA 5035 EPA 5035A	---
Aromatic Volatiles by GC	Water		EPA 602	EPA 5030B	---
	Waste		---	EPA 5030B EPA 5035	---
	Solid		---	EPA 5035 EPA 5035A	---
Semivolatiles by GC/MS	Water		EPA 625	EPA 3510C EPA 3520C	---
	TCLP Leachate		---	EPA 3510C EPA 3520C	---
	Waste		---	EPA 3550B EPA 3540C EPA 3580A EPA 3541	---
	Solid		---	EPA 3550B EPA 3540C EPA 3541	---
Pesticides/PCBs by GC	Water		EPA 608	EPA 3510C EPA 3520C	---
	TCLP Leachate		---	EPA 3510C EPA 3520C	---
	Waste		---	EPA 3550B EPA 3540C EPA 3580A EPA 3541	---
	Solid		---	EPA 3550B EPA 3540C EPA 3541	---

Analytical Parameters	Matrix	Fields of Testing			
			CWA	RCRA (SW846)	Other
Herbicides by GC	Water		EPA 615	EPA 8151A	---
	Waste		---	EPA 8151A	---
	Solid		---	EPA 8151A	---
Total Petroleum Hydrocarbons (Gasoline Range) by GC	Water		---	EPA 5030B	WI GRO
	Waste		---	EPA 5030B EPA 5035	WI GRO
	Solid		---	EPA 5035 EPA 5035	WI GRO
Total Petroleum Hydrocarbons (Diesel Range) by GC	Water		---	EPA 3510C EPA 3520C	WI DRO
	TCLP Leachate		---	EPA 3510C EPA 3520C	---
	Waste		---	EPA 3550B EPA 3580A	WI DRO
	Solid		---	EPA 3550B	WI DRO

TABLE 19-7. Organic Methods of Analysis

Analytical Parameters	Matrix	Fields of Testing			
			CWA	RCRA (SW846)	Other
Volatiles by GC/MS	Water		EPA 624	EPA 8260B	---
	Waste		---	EPA 8260B	---
	Solid		---	EPA 8260B	---
Halogenated Volatiles by GC	Water		EPA 601	EPA 8021B	---
	Waste		---	EPA 8021B	---
	Solid		---	EPA 8021B	---
Aromatic Volatiles by GC	Water		EPA 602	EPA 8021B	---
	Waste		---	EPA 8021B	---
	Solid		---	EPA 8021B	---
Semivolatiles by GC/MS	Water		EPA 625	EPA 8270C	
	Waste		---	EPA 8270C	---
	Solid		---	EPA 8270C	---
Pesticides/PCBs by GC	Water		EPA 608	Pesticides 8081A PCBs 8082	---
	TCLP Leachate		---	Pesticides 8081A PCBs 8082	---
	Waste		---	Pesticides 8081A PCBs 8082	---
	Solid		---	Pesticides 8081A PCBs 8082	---
Phenoxyacid Herbicides by GC	Water		---	EPA 8151A	---
	TCLP Leachate		---	EPA 8151A	---
	Waste		---	EPA 8151A	---
	Solid		---	EPA 8151A	---
Gasoline Range Organics by GC	Water		---	EPA 8015B (M)	WI GRO
	Waste		---	EPA 8015B (M)	---
	Solid		---	EPA 8015B (M)	WI GRO
Total Petroleum Hydrocarbons (Diesel Range) by GC/FID	Water		---	EPA 8015B (M)	WI DRO
	Waste		---	EPA 8015B (M)	---
Dissolved Gases RSK-175	Water		---	---	SOP
Formaldehyde Carbonyl Compounds	Water		---	EPA 8315	---

The laboratory reviews updated versions to all the aforementioned references for adaptation based upon capabilities, instrumentation, etc., and implements them as appropriate. As such, the laboratory strives to perform only the latest versions of each approved method as regulations allow or require.

Other reference procedures for non-routine analyses may include methods established by specific states (e.g., Underground Storage Tank methods), ASTM or equipment manufacturers. Sample type, source, and the governing regulatory agency requiring the analysis will determine the method utilized.

The laboratory must inform the client when a method proposed by the client may be inappropriate or out of date. After the client has been informed, and they wish to proceed contrary to the laboratory's recommendation, it must be documented.

19.4.2 Demonstration of Capability

Before the laboratory may institute a new method and begin reporting results, the laboratory must confirm that it can properly operate the method. In general, this demonstration does not test the performance of the method in real world samples, but in an applicable and available clean matrix sample. If the method is for the testing of analytes that are not conducive to spiking, demonstration of capability may be performed on quality control samples.

19.4.2.1 A demonstration of capability is performed (SOP NC-QA-028, Employee Orientation and Training) whenever there is a change in instrument type (e.g., new instrumentation), method, or personnel.

19.4.2.2 The initial demonstration of capability must be thoroughly documented and approved by the Technical Director and QA Manager prior to independently analyzing client samples. All associated documentation must be retained in accordance with the laboratories archiving procedures.

19.4.2.3 The laboratory must have an approved SOP, demonstrate satisfactory performance, and conduct an MDL study (when applicable). There may be other requirements as stated within the published method or regulations (i.e., retention time window study).

Note: In some instances, a situation may arise where a client requests that an unusual analyte be reported using a method where this analyte is not normally reported. If the analyte is being reported for regulatory purposes, the method must meet all procedures outlined within this QA Manual (SOP, MDL, and Demonstration of Capability). If the client states that the information is not for regulatory purposes, the result may be reported as long as the following criteria are met:

- The instrument is calibrated for the analyte to be reported using the criteria for the method and ICV/CCV criteria are met (unless an ICV/CCV is not required by the method or criteria are per project DQOs).
- The laboratory's nominal or default reporting limit (RL) is equal to the quantitation limit (QL), must be at or above the lowest non-zero standard in the calibration curve (low standard at or below the QL) and must be reliably determined. Project RLs are client specified reporting levels which may be higher than the QL. Results reported

below the QL must be qualified as estimated values. Also see Section 19.6.1.3, Relationship of Limit of Detection (LOD) to Quantitation Limit (QL).

Note: For Ohio VAP work, the term Reporting Limit will be used.

- The client request is documented and the lab informs the client of its procedure for working with unusual compounds. The final report must be footnoted as “*Reporting Limit based on the low standard of the calibration curve*”.

19.4.3 Initial Demonstration of Capability (IDOC) Procedures

19.4.3.1 At least four aliquots must be prepared (including any applicable clean-up procedures) and analyzed according to the test method (either concurrently or over a period of days).

19.4.3.2 Using all of the results, calculate the mean recovery in the appropriate reporting units and the standard deviations for each parameter of interest. Refer to SOP NC-QA-028, Employee Orientation and Training, for details on this procedure.

Note: Results of successive LCS analyses can be used to fulfill the DOC requirement.

19.4.3.3 A certification statement (see Figure 19-1 as an example) must be used to document the completion of each initial demonstration of capability. A copy of the certification is archived in the analyst’s training folder.

19.5 LABORATORY-DEVELOPED METHODS AND NON-STANDARD METHODS

Any new method developed by the laboratory must be fully defined in an SOP and validated by qualified personnel with adequate resources to perform the method. Method specifications and the relation to client requirements must be clearly conveyed to the client if the method is a non-standard method (not a published or routinely accepted method). The client must also be in agreement to the use of the non-standard method.

19.6 VALIDATION OF METHODS

Validation is the confirmation by examination and the provision of objective evidence that the particular requirements for a specific intended use are fulfilled.

All non-standard methods, laboratory designed/developed methods, standard methods used outside of their scope, and major modifications to published methods must be validated to confirm they are fit for their intended use. The validation will be as extensive as necessary to meet the needs of the given application. The results are documented with the validation procedure used and contain a statement as to the fitness for use.

19.6.1 Method Validation and Verification Activities for All New Methods

While method validation can take various courses, the following activities can be required as part of method validation. Method validation records are designated QC records and are archived accordingly.

19.6.1.1 Determination of Method Selectivity

Method selectivity is the demonstrated ability to discriminate the analyte(s) of interest from other compounds in the specific matrix or matrices from other analytes or interference. In some cases to achieve the required selectivity for an analyte, a confirmation analysis is required as part of the method.

19.6.1.2 Determination of Method Sensitivity

Sensitivity can be both estimated and demonstrated. Whether a study is required to estimate sensitivity depends on the level of method development required when applying a particular measurement system to a specific set of samples. Where estimations and/or demonstrations of sensitivity are required by regulation or client agreement, such as the procedure in 40 CFR Part 136 Appendix B, under the Clean Water Act, these shall be followed.

19.6.1.3 Relationship of Limit of Detection (LOD) to the Quantitation Limit (QL)

An important characteristic of expression of sensitivity is the difference in the LOD and the QL. The LOD is the minimum level at which the presence of an analyte can be reliably concluded. The QL is the minimum concentration of analyte that can be quantitatively determined with acceptable precision and bias. For most instrumental measurement systems, there is a region where semi-quantitative data is generated around the LOD (both above and below the estimated MDL or LOD) and below the QL. In this region, detection of an analyte may be confirmed but quantification of the analyte is unreliable within the accuracy and precision guidelines of the measurement system. When an analyte is detected below the QL, and the presence of the analyte is confirmed by meeting the qualitative identification criteria for the analyte, the analyte can be reliably reported, but the amount of the analyte can only be estimated. If data is to be reported in this region, it must be done so with a qualification that denotes the semi-quantitative nature of the result.

19.6.1.4 Determination of Interferences

A determination that the method is free from interferences in a blank matrix is performed.

19.6.1.5 Determination of Range

Where appropriate to the method, the quantitation range is determined by comparison of the response of an analyte in a curve to established or targeted criteria. Generally the upper quantitation limit is defined by highest acceptable calibration concentration. The lower quantitation limit or QL cannot be lower than the lowest non-zero calibration level, and can be constrained by required levels of bias and precision.

19.6.1.6 Determination of Accuracy and Precision

Accuracy and precision studies are generally performed using replicate analyses, with a resulting percent recovery and measure of reproducibility (standard deviation, relative standard deviation) calculated and measured against a set of target criteria.

19.6.1.7 Documentation of Method

The method is formally documented in an SOP. If the method is a minor modification of a standard laboratory method that is already documented in an SOP, an SOP Attachment describing the specific differences in the new method is acceptable in place of a separate SOP.

19.6.1.8 Continued Demonstration of Method Performance

Continued demonstration of Method Performance is addressed in the SOP. Continued demonstration of method performance is generally accomplished by batch-specific QC samples such as LCS, method blanks, or PT samples.

19.7 METHOD DETECTION LIMITS (MDL)/ LIMITS OF DETECTION (LOD)

Method detection limits (MDL) are initially determined in accordance with 40 CFR Part 136, Appendix B, or alternatively by other technically acceptable practices that have been accepted by regulators. MDL is also sometimes referred to as Limit of Detection (LOD). The MDL theoretically represents the concentration level for each analyte within a method at which the Analyst is 99% confident that the true value is not zero. The MDL is determined for each analyte initially during the method validation process and updated as required in the analytical methods, whenever there is a significant change in the procedure or equipment, or based on project specific requirements (refer to Section 19.7.10). Generally, the analyst prepares at least seven replicates of solution spiked at one to five times the estimated method detection limit (most often at the lowest standard in the calibration curve) into the applicable matrix with all the analytes of interest. Each of these aliquots is extracted (including any applicable clean-up procedures) and analyzed in the same manner as the samples. Where possible, the seven replicates should be analyzed over 2-4 days to provide a more realistic MDL. To allow for some flexibility, this low level standard may be analyzed every batch or every week or some other frequency rather than doing the study all at once. In addition, a larger number of data points may be used if the appropriate t-value multiplier is used.

Refer to the Corporate SOP CA-Q-S-006 or the laboratory's SOP NC-QA-021 for details on the laboratory MDL process.

Note: For Ohio VAP projects, the MDL procedure must also comply with OAC Rule 3745-300-01(A)(78).

19.8 INSTRUMENT DETECTION LIMITS (IDL)

19.8.1 The IDL is sometimes used to assess the reasonableness of the MDLs or in some cases required by the analytical method or program requirements. IDLs are most used in metals analyses but may be useful in demonstration of instrument performance in other areas.

19.8.2 IDLs are calculated to determine an instrument's sensitivity independent of any preparation method. IDLs are calculated either by using seven replicate spike analyses, like MDL but without sample preparation, or by the analysis of ten instrument blanks and calculating three times the absolute value of the standard deviation.

19.8.3 If IDL is > than the MDL, it may be used as the reported MDL.

19.9 VERIFICATION OF DETECTION AND REPORTING LIMITS

19.9.1 Once the MDL is determined, it must be verified on each instrument used for the given method. TestAmerica defines the DoD QSM Detection Limit (DL) as being equal to the MDL. TestAmerica also defines the DoD QSM Limit of Detection (LOD) as being equal to the lowest concentration standard that successfully verifies the MDL, also referred to as the MDLV standard. MDL and MDLV standards are extracted/digested and analyzed through the entire analytical process. The MDL and MDLV determinations do not apply to methods that are not readily spiked (e.g. pH, turbidity, etc.) or where the lab does not report to the MDL. If the MDLV standard is not successful, then the laboratory will redevelop their MDL. Initial and quarterly verification is required for all methods listed in the laboratory's DoD ELAP Scope of Accreditation. Refer to the laboratory SOP NC-QA-021 or Corporate CA-Q-S-006 for further details.

19.9.2 The laboratory quantitation limit is equivalent to the DoD Limit of Quantitation (LOQ), which is at a concentration equal to or greater than the lowest non-zero calibration standard. The DoD QSM requires the laboratory to perform an initial characterization of the bias and precision at the LOQ and quarterly LOQ verifications thereafter. If the quarterly verification results are not consistent with three-standard deviation confidence limits established initially, then the bias and precision will be reevaluated and clients contacted for any on-going projects. For DoD projects, TestAmerica makes a distinction between the Reporting Limit (RL) and the LOQ. The RL is a level at or above the LOQ that is used for specific project reporting purposes, as agreed to between the laboratory and the client. The RL cannot be lower than the LOQ concentration, but may be higher.

19.10 RETENTION TIME WINDOWS

Most organic analyses and some inorganic analyses use chromatography techniques for qualitative and quantitative determinations. For every chromatography analysis each analyte will have a specific time of elution from the column to the detector. This is known as the analyte's retention time. The variance in the expected time of elution is defined as the retention time window. As the key to analyte identification in chromatography, retention time windows must be established on every column for every analyte used for that method. These records are kept in each department. Complete details are available in the laboratory SOPs.

19.11 EVALUATION OF SELECTIVITY

The laboratory evaluates selectivity by following the checks within the applicable analytical methods, which include mass spectral tuning, second column confirmation, ICP interelement interference checks, chromatography retention time windows, sample blanks, atomic absorption, or fluorescence profiles.

19.12 ESTIMATION OF UNCERTAINTY OF MEASUREMENT

19.12.1 Uncertainty is “a parameter associated with the result of a measurement, that characterizes the dispersion of the values that could reasonably be attributed to the measurand” (as defined by the International Vocabulary of Basic and General Terms in Metrology, ISO Geneva, 1993, ISBN 92-67-10175-1). Knowledge of the uncertainty of a measurement provides additional confidence in a result’s validity. Its value accounts for all the factors which could possibly affect the result, such as adequacy of analyte definition, sampling, matrix effects and interferences, climatic conditions, variances in weights, volumes, and standards, analytical procedure, and random variation. Some national accreditation organizations require the use of an “expanded uncertainty”: the range within which the value of the measurand is believed to lie within at least a 95% confidence level with the coverage factor $k=2$.

19.12.2 Uncertainty is not error. Error is a single value, the difference between the true result and the measured result. On environmental samples, the true result is never known. The measurement is the sum of the unknown true value and the unknown error. Unknown error is a combination of systematic error, or bias, and random error. Bias varies predictably, constantly, and independently from the number of measurements. Random error is unpredictable, assumed to be Gaussian in distribution, and reducible by increasing the number of measurements.

19.12.3 The minimum uncertainty associated with results generated by the laboratory can be determined by using the Laboratory Control Sample (LCS) accuracy range for a given analyte. The LCS limits are used to assess the performance of the measurement system since they take into consideration all of the laboratory variables associated with a given test over time (except for variability associated with the sampling and the variability due to matrix effects). The percent recovery of the LCS is compared either to the method-required LCS accuracy limits or to the statistical, historical, in-house LCS accuracy limits.

19.12.4 To calculate the uncertainty for the specific result reported, multiply the result by the decimal of the lower end of the LCS range percent value for the lower end of the uncertainty range, and multiply the result by the decimal of the upper end of the LCS range percent value for the upper end of the uncertainty range. These calculated values represent a 99%-certain range for the reported result. As an example, suppose that the result reported is 1.0 mg/l, and the LCS percent recovery range is 50 to 150%. The uncertainty range would be 0.5 to 1.5 mg/l, which could also be written as 1.0 ± 0.5 mg/l.

19.12.5 In the case where a well recognized test method specifies limits to the values of major sources of uncertainty of measurement, e.g., 524.2, 525, etc., and specifies the form of presentation of calculated results, no further discussion of uncertainty is required.

19.13 CONTROL OF DATA

The laboratory has policies and procedures in place to ensure the authenticity, integrity, and accuracy of the analytical data generated by the laboratory.

19.13.1 Computer and Electronic Data Related Requirements

The three basic objectives of our computer security procedures and policies are shown below. The laboratory is currently running the QuantIMS LIMS which is a custom in-house developed LIMS system that has been highly customized to meet the needs of the laboratory. It is referred to as LIMS for the remainder of this section. The LIMS utilizes AS400 which is an industry standard relational database platform. It is referred to as Database for the remainder of this section.

19.13.1.1 Maintain the Database Integrity

Assurance that data is reliable and accurate through data verification (review) procedures, password-protecting access, anti-virus protection, data change requirements, as well as an internal LIMS permissions procedure.

- LIMS Database Integrity is achieved through data input validation, internal user controls, and data change requirements.
- Spreadsheets and other software developed in-house must be verified with documentation through hand calculations prior to use.

19.13.1.2 Ensure Information Availability

Protection against loss of information or service is ensured through scheduled back-ups, stable file server network architecture, secure storage of media, line filter, Uninterruptible Power Supply (UPS), and maintaining older versions of software as revisions are implemented.

19.13.1.3 Maintain Confidentiality

Ensure data confidentiality through physical access controls, and encryption of when electronically transmitting data.

19.13.2 Data Reduction

The complexity of the data reduction depends on the analytical method and the number of discrete operations involved, e.g., extractions, dilutions, instrument readings and concentrations. The analyst calculates the final results from the raw data or uses appropriate computer programs to assist in the calculation of final reportable values.

For manual data entry, e.g., Wet Chemistry, the data is reduced by the analyst and then verified by peer review once updated in LIMS. The review checklists are signed by both the analyst and reviewer to confirm the accuracy of the manual entry(s).

Manual integration of peaks will be documented and reviewed and the raw data will be flagged in accordance with the TestAmerica Corporate SOP CA-Q-S-002, Acceptable Manual Integration Practices.

Analytical results are reduced to appropriate concentration units specified by the analytical method, taking into account factors such as dilution, sample weight or volume, etc. Blank correction will be applied only when required by the method or per manufacturer's indication; otherwise, it must not be performed. Calculations are independently verified by appropriate laboratory staff. Calculations and data reduction steps for various methods are summarized in the respective analytical SOPs or program requirements.

19.13.2.1 All raw data must be retained. All criteria pertinent to the method must be recorded. The documentation is recorded at the time observations or calculations are made and must be signed or initialed/dated (month/day/year). It must be easily identifiable who performed which tasks if multiple people were involved.

19.13.2.2 In general, concentration results are reported in milligrams per liter (mg/l) or micrograms per liter ($\mu\text{g/l}$) for liquids and milligrams per kilogram (mg/kg) or micrograms per kilogram ($\mu\text{g/kg}$) for solids. The units "mg/l" and "mg/kg" are the same as "parts per million (ppm)". The units " $\mu\text{g/l}$ " and " $\mu\text{g/kg}$ " are the same as "parts per billion (ppb)". For values greater than 10,000 mg/l, results can be reported in percent, i.e., 10,000 mg/l = 1%. Units are defined in each lab SOP.

19.13.2.3 For those methods that do not have an instrument printout or an instrumental output compatible with the LIMS System, the raw results and dilution factors are entered directly into LIMS by the analyst, and the software calculates the final result for the analytical report. LIMS has a defined significant figure criterion for each analyte.

19.13.2.4 The laboratory strives to import data directly from instruments or calculation spreadsheets to ensure that the reported data are free from transcription and calculation errors. For those analyses with an instrumental output compatible with the LIMS, the raw results and dilution factors are transferred into LIMS electronically after reviewing the quantitation report, and removing unrequested or poor spectrally-matched compounds. The analyst prints a copy of what has been entered to check for errors. This printout and the instrument's printout of calibrations, concentrations, retention times, chromatograms, and mass spectra, if applicable, are retained with the data file.

19.13.3 Logbook / Worksheet Use Guidelines

Logbooks and worksheets are filled out in 'real time' and have enough information on them to trace the events of the applicable analysis/task (e.g., calibrations, standards, analyst, sample ID, date, time on short holding time tests, temperatures when applicable, calculations are traceable, etc.).

- Corrections are made following the procedures outlined in Section 12.
- Logbooks are controlled by the QA Department. A record is maintained of all logbooks in the lab.

- Unused portions of pages must be “Z”d out, signed and dated.
- Worksheets are created with the approval of the QA Manager at the facility. The QA Manager controls all worksheets following the procedures in Section 6.

19.13.4 Review / Verification Procedures

19.13.4.1 Data Recording Procedures

To ensure data integrity, all documentation of data and records generated or used during the process of data generation must be performed in compliance with Section 3 of this document and Policy CA-Q-T-005, Laboratory Documentation.

19.13.4.2 Data Reduction and Verification Procedures

Data review procedures comprise a set of computerized and manual checks applied at appropriate levels of the measurement process. Data review begins with the reduction or processing of data and continues through verification of the data and the reporting of analytical results. Calculations are checked from the raw data to the final value prior to reporting results for each group of samples. Data reduction can be performed by the analyst who obtained the data or by another analyst. Data verification starts with the analyst who performs a 100% review of the data to ensure the work was done correctly the first time. Data verification continues with review by a second reviewer who verifies that data reduction has been correctly performed and that the analytical results correspond to the data acquired and processed.

19.13.4.2.1 Data Reduction and Initial Verification

Data reduction and initial verification may be performed by more than one analyst depending upon the analytical method employed. The preparation and analytical data may be reviewed independently by different analysts. In these instances, each item may not be applicable to the subset of the data verified or an item may be applicable in both instances. It is the responsibility of the analyst to ensure that the verification of data in his or her area is complete. The data reduction and initial verification process must ensure that:

- Sample preparation information is correct and complete including documentation of standard identification, solvent lot numbers, sample amounts, etc.
- Analysis information is correct and complete including proper identification of analysis output (charts, chromatograms, mass spectra, etc.)
- Analytical results are correct and complete including calculation or verification of instrument calibration, QC results, and qualitative and quantitative sample results with appropriate qualifiers
- The appropriate SOPs have been followed and are identified in the project and/or laboratory records
- Proper documentation procedures have been followed
- All non-conformances have been documented
- Special sample preparation and analytical requirements have been met.
- The data generated have been reported with the appropriate number of significant figures as defined by the analytical method in the LIMS or

otherwise specified by the client.

In general, data will be processed by an analyst in one of the following ways:

- Manual computation of results directly on the data sheet or on calculation pages attached to the data sheets
- Input of raw data for computer processing
- Direct acquisition and processing of raw data by a computer.

If data are manually processed by an analyst, all steps in the computation must be provided including equations used and the source of input parameters such as response factors (RFs), dilution factors, and calibration constants. If calculations are not performed directly on the data sheet, they may be attached to the data sheets.

Manual integrations are sometimes necessary to correct misintegrations by an automatic data system software program, but must only be performed when necessary. Further discussion of manual integrations and the required documentation is given in Policy CA-Q-S-002, Acceptable Manual Integration Practices.

For data that are input by an analyst and processed using a computer, a copy of the input must be kept and uniquely identified with the project number and other information as needed. The samples analyzed must be clearly identified.

If data are directly acquired from instrumentation or a test procedure and processed, or immediately entered into LIMS, the analyst must verify that the following are correct:

- Project and sample numbers
- Calibration constants and RFs
- Units
- Numerical values used for reporting limits.

Analysis-specific calculations for methods are provided in SOPs. In cases where computers perform the calculations, software must be validated or verified, as described in Section 6.0 of this document, before it is used to process data.

The data reduction is documented, signed and dated by the analyst completing the process. Initial verification of the data reduction by the same analyst is documented on a data review checklist, signed and dated by the analyst.

19.13.4.2.2 Data Verification

Following the completion of the initial verification by the analyst performing the data reduction, a systematic check of the data that has been fully reduced and checked through Level 1 review is performed by an experienced peer, group leader, or designee. This Level 2 check is performed to ensure that Level 1 review has been completed correctly and thoroughly. The second level

reviewer examines the data signed by the analyst. Any exceptions noted by the analyst must be reviewed. Included in this review is an assessment of the acceptability of the data with respect to:

- Adherence of the procedure used to the requested analytical method SOP
- Correct interpretation of chromatograms, mass spectra, etc.
- Correctness of numerical input when computer programs are used (checked randomly)
- Correct identification and quantitation of constituents with appropriate qualifiers
- Numerical correctness of calculations and formulas (checked randomly)
- Acceptability of QC data (100% review)
- Documentation that instruments were operating according to method specifications (calibrations, performance checks, etc.)
- Documentation of dilution factors, standard concentrations, etc.
- Sample holding time assessment.

This review also serves as verification that the process the analyst has followed is correct in regard to the following:

- The analytical procedure follows the methods and client-specific instructions.
- Nonconforming events have been addressed by corrective action as defined on a nonconformance memo
- Valid interpretations have been made during the examination of the data and the review comments of the initial reviewer are correct
- The package contains all of the necessary documentation for data review and report production and results are reported in a manner consistent with the method used for preparation of data reports.

The specific items covered in the second stage of data verification may vary according to the analytical method, but this review of the data must be documented by signing the same checklist.

19.13.4.2.3 Completeness Verification

A third-level review is performed by the reporting and project management staff. This review is required before results are submitted to clients. This review serves to verify the completeness of the data report and to ensure that project requirements are met for the analyses performed. The items to be reviewed are:

- Analysis results are present for every sample in the analytical batch, reporting group, or sample delivery group (SDG)
- Every parameter or target compound requested is reported with either a value or reporting limit
- All nonconformances, including holding time violations, and data evaluation statements that impact the data quality are accompanied by clearly expressed comments from the laboratory
- The final report contains all the supporting documentation required by the project, and is in either the standard TestAmerica format or in the client-required

format.

- Implement checks to monitor the quality of laboratory results using correlation of results for different parameters of a sample (for example, does the TOC results justify the concentration of organic compounds found by GC/MS.)
- A narrative to accompany the final report must be finalized by the PM. This narrative must include relevant comments collected during the earlier reviews.

The Quality Assurance Department performs data reviews per SOP CA-Q-S-004, Internal Auditing. For DoD work, 10% of all reports must undergo an internal data review.

19.13.5 Manual Integrations

Computerized data systems provide the analyst with the ability to re-integrate raw instrument data in order to optimize the interpretation of the data. Though manual integration of data is an invaluable tool for resolving variations in instrument performance and some sample matrix problems, when used improperly, this technique would make unacceptable data appear to meet quality control acceptance limits. Improper re-integrations lead to legally indefensible data, a poor reputation, or possible laboratory decertification. Because guidelines for re-integration of data are not provided in the methods and most methods were written prior to widespread implementation of computerized data systems, the laboratory trains all analytical staff on proper manual integration techniques using TestAmerica's Corporate SOP (CA-Q-S-002).

19.13.5.1 The analyst must adjust baseline or the area of a peak in some situations, for example when two compounds are not adequately resolved or when a peak shoulder needs to be separated from the peak of interest. The analyst must use professional judgment and common sense to determine when manual integrating is required. Analysts are encouraged to ask for assistance from a senior analyst or manager when in doubt.

19.13.5.2 Analysts must not increase or decrease peak areas to for the sole purpose of achieving acceptable QC recoveries that would have otherwise been unacceptable. The intentional recording or reporting of incorrect information (or the intentional omission of correct information) is against company principals and policy and is grounds for immediate termination.

19.13.5.3 Client samples, performance evaluation samples, and quality control samples are all treated equally when determining whether or not a peak area or baseline should be manually adjusted.

19.13.5.4 All manual integrations receive a second level review. Manual integrations must be indicated on an expanded scale "after" chromatograms such that the integration performed can be easily evaluated during data review. Expanded scale "before" chromatograms are also required for all manual integrations on QC parameters (calibrations, calibration verifications, laboratory control samples, internal standards, surrogates, etc.) unless the laboratory has another documented corporate-approved procedure in place that can demonstrate an active process for detection and deterrence of improper integration practices.

Figure 19-1. Example - Demonstration of Capability Documentation

Analyst Demonstration of Capability **Certification Statement**

Analyst Name

Date:

Test Method:

SOP:

Matrix:

TestAmerica North Canton laboratory
4101 Shuffel Drive NW
North Canton, OH 44720
(330) 497-9396

We, the undersigned, CERTIFY that:

1. The analyst identified above, using the cited test method with the specifications in the cited SOP, which is in use at this facility for the analysis of samples under the TestAmerica Quality Assurance Plan, has met the Initial or Ongoing Demonstration of Capability.
2. The test method was performed by the analyst identified on this certification following the TestAmerica SOP.
3. A copy of the laboratory-specific SOP is available for all personnel on-site.
4. The data associated with the initial/ongoing demonstration of capability are true, accurate, complete and self-explanatory (*). These data are attached to this certification statement.
5. All raw data (including a copy of this certification form) necessary to reconstruct and validate these analyses have been retained at the facility, and that the associated information is well organized and available for review by authorized inspectors.

Comments/Observations:

Analyst's Name	Signature	Date
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Technical Director's Name	Signature	Date
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QA Manager's Name	Signature	Date
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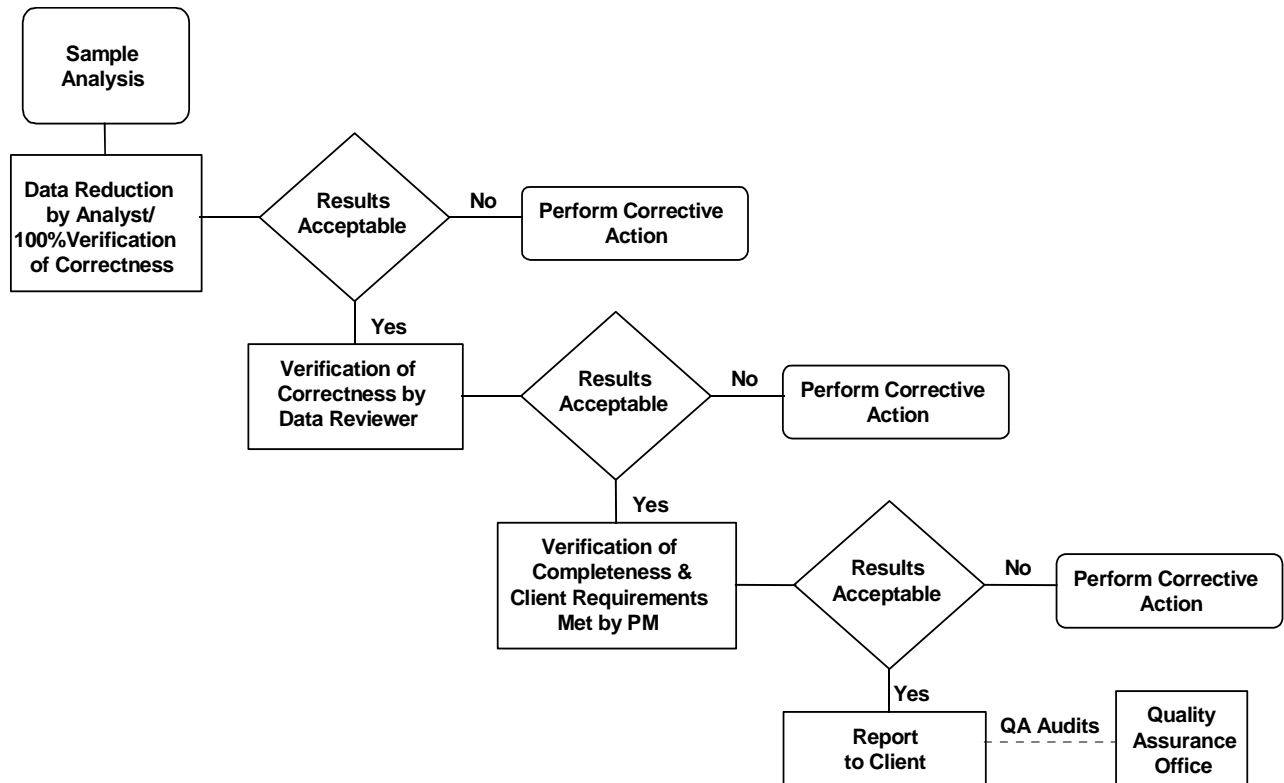
* *True: Consistent with supporting data.*

Accurate: Based on good laboratory practices consistent with sound scientific principles/practices.

Complete: Includes the results of all supporting performance testing.

Self-explanatory: Data properly labeled and stored so that the results are traceable and require no additional explanation.

Figure 19-2. Work Flow



SECTION 20

EQUIPMENT (AND CALIBRATIONS) **(NELAC 5.5.5)**

20.1 OVERVIEW

The laboratory purchases the most technically advanced analytical instrumentation for sample analyses. Instrumentation is purchased on the basis of accuracy, dependability, efficiency and sensitivity. Each laboratory is furnished with all items of sampling, preparation, analytical testing and measurement equipment necessary to correctly perform the tests for which the laboratory has capabilities. Each piece of equipment is capable of achieving the required accuracy and complies with specifications relevant to the method being performed. Before being placed into use, the equipment (including sampling equipment) is calibrated and checked to establish that it meets its intended specification. The calibration routines for analytical instruments establish the range of quantitation. Calibration procedures are specified in laboratory SOPs. A list of laboratory equipment and instrumentation is presented in Table 20-1.

Equipment is only operated by authorized and trained personnel. Manufacturers instructions for equipment use are readily accessible to all appropriate laboratory personnel.

20.2 PREVENTIVE MAINTENANCE

20.2.1 The laboratory follows a well-defined maintenance program to ensure proper equipment operation and to prevent the failure of laboratory equipment or instrumentation during use. This program of preventive maintenance helps to avoid delays due to instrument failure.

20.2.2 Routine preventive maintenance procedures and frequency, such as lubrication, cleaning, and replacements, should be performed according to the procedures outlined in the manufacturer's manual. Qualified personnel must also perform maintenance when there is evidence of degradation of peak resolution, a shift in the calibration curve, loss of sensitivity, or failure to continually meet one of the quality control criteria.

20.2.3 Table 20-2 lists examples of scheduled routine maintenance. It is the responsibility of each Group Leader to ensure instrument maintenance logs are kept for all equipment in his/her department. Preventative maintenance procedures are also be outlined in analytical SOPs or instrument manuals. (Note: For some equipment, the log used to monitor performance is also the maintenance log. Multiple pieces of equipment may share the same log as long as it is clear as to which instrument is associated with an entry.)

20.2.4 Instrument maintenance logs are controlled and are used to document instrument problems, instrument repair and maintenance activities. Maintenance logs must be kept for all major pieces of equipment. Instrument Maintenance Logbooks may also be used to specify instrument parameters.

20.2.4.1 Documentation must include all major maintenance activities such as contracted preventive maintenance and service and in-house activities such as the replacement of electrical components, lamps, tubing, valves, columns, detectors, cleaning and adjustments.

20.2.4.2 Each entry in the instrument log includes the Analyst's initials, date, a detailed description of the problem (or maintenance needed/scheduled), a detailed explanation of the solution or maintenance performed, and a verification that the equipment is functioning properly (state what was used to determine a return to control, e.g., CCV run on 'date' was acceptable, or instrument recalibrated on 'date' with acceptable verification, etc.) must also be documented in the instrument records.

20.2.4.3 When maintenance or repair is performed by an outside agency, service receipts detailing the service performed can be affixed into the logbooks adjacent to pages describing the maintenance performed. This stapled-in page must be signed across the page entered and the logbook, so it is clear that a page is missing if only half a signature is found in the logbook.

20.2.5 Instrument Repair

If an instrument requires repair (subjected to overloading or mishandling, gives suspect results, or otherwise has shown to be defective or outside of specified limits) it must be taken out of operation and tagged as out of service or otherwise isolated until such a time as the repairs have been made and the instrument can be demonstrated as operational by calibration and/or verification or other test to demonstrate acceptable performance. The laboratory must examine the effect of this defect on previous analyses.

20.2.6 Equipment Malfunction

In the event of equipment malfunction that cannot be resolved, service shall be obtained from the instrument vendor manufacturer, or qualified service technician, if such a service can be tendered. If on-site service is unavailable, arrangements shall be made to have the instrument shipped back to the manufacturer for repair. Backup instruments, which have been approved, for the analysis shall perform the analysis normally carried out by the malfunctioning instrument. If the backup is not available and the analysis cannot be carried out within the needed timeframe, the samples must be subcontracted.

20.2.7 Instrument Transfer or Send-Out

If an instrument is sent out for service or transferred to another facility, it must be recalibrated and verified (including new initial MDL study) prior to return to lab operations.

20.3 SUPPORT EQUIPMENT

This section applies to all devices that may not be the actual test instrument, but are necessary to support laboratory operations. These include but are not limited to balances, ovens, refrigerators, freezers, incubators, water baths, field sampling devices, temperature measuring devices, dispensing devices, if quantitative results are dependent on their accuracy, as in standard preparation and dispensing or dilution into a specified volume. All raw data records associated with the support equipment are retained to document instrument performance.

20.3.1 Weights and Balances

The accuracy of the balances used in the laboratory is checked every working day, before use. All balances are placed on stable counter tops.

Each balance is checked prior to initial serviceable use with at least two certified ASTM Type 1 weights spanning its range of use (weights that have been calibrated to ASTM Type 1 weights may also be used for daily verification). ASTM Type 1 weights used only for calibration of other weights (and no other purpose) are inspected for corrosion, damage or nicks at least annually and if no damage is observed. They are calibrated at least every five years by an outside calibration laboratory. Any weights (including ASTM Type 1) used for daily balance checks or other purposes are recalibrated/recertified annually to NIST standards (this may be done internally if laboratory maintains "calibration only" ASTM Type 1 weights).

All balances are serviced annually by a qualified service representative, who supplies the laboratory with a certificate that identifies traceability of the calibration to the NIST standards.

All of this information is recorded in logs, and the recalibration/recertification certificates are kept on file. Reference SOP NC-QA-015, Equipment Monitoring and Thermometer Calibration. A list of balances is in Table 21.2.

20.3.2 pH, Conductivity, and Turbidity Meters

The pH meters used in the laboratory are accurate to ± 0.1 pH units, and have a scale readability of at least 0.05 pH units. The meters automatically compensate for the temperature, and are calibrated with at least two working range buffer solutions before each use.

Conductivity meters are also calibrated before each use with a known standard to demonstrate the meters do not exceed an error of 1% or one umhos/cm.

Turbidity meters are also calibrated before each use. All of this information is documented in logs.

Consult pH and Conductivity, and Turbidity SOPs for further information.

20.3.3 Thermometers

All thermometers are calibrated on an annual basis with a NIST-traceable thermometer. IR thermometers, digital probes, and thermocouples are calibrated quarterly.

The NIST thermometer is recalibrated every three years (unless thermometer has been exposed to temperature extremes or apparent separation of internal liquid) by an approved outside service and the provided certificate of traceability is kept on file. The NIST thermometer(s) have increments of 1 degree (0.5 degree or less increments are required for drinking water microbiological laboratories), and have ranges applicable to method and certification requirements. The NIST traceable thermometer is used for no other purpose than to calibrate other thermometers.

All of this information is documented in logsheets. Monitoring method-specific temperatures, including incubators, heating blocks, water baths, and ovens, is documented in method-specific logsheets. More information on this subject can be found in SOP NC-QA-015, Equipment Monitoring and Thermometer Calibration.

20.3.4 Refrigerators/Freezer Units, Waterbaths, Ovens and Incubators

The temperatures of all refrigerator units and freezers used for sample and standard storage are monitored each working day (seven days a week for DOD labs).

Ovens, waterbaths and incubators are monitored on days of use.

All of this equipment has a unique identification number, and is assigned a unique thermometer for monitoring.

Sample storage refrigerator temperatures are kept between or $4 \pm 2^{\circ}\text{C}$.

Specific temperature settings/ranges for other refrigerators, ovens waterbaths, and incubators can be found in method specific SOPs.

All of this information is documented in Daily Temperature Logsheets posted on each unit and method-specific logbooks.

20.3.5 Autopipettors, Dilutors, and Syringes

Mechanical volumetric dispensing devices including burettes (except Class A Glassware) are given unique identification numbers and the delivery volumes are verified gravimetrically, at a minimum, on a quarterly basis. Glass micro-syringes are considered the same as Class A glassware.

Micro-syringes are purchased from Hamilton Company. Each syringe is traceable to NIST. The laboratory keeps on file an "Accuracy and Precision Statement of Conformance" from Hamilton attesting established accuracy.

The laboratory maintains a sufficient inventory of autopipettors, and dilutors of differing capacities that fulfill all method requirements.

These devices are given unique identification numbers, and the delivery volumes are verified gravimetrically, at a minimum, on a quarterly basis.

Any device not regularly verified cannot be used for any quantitative measurements.

Micro-syringes are purchased from Hamilton Company. Each syringe is traceable to NIST. The laboratory keeps on file an "Accuracy and Precision Statement of Conformance" from Hamilton attesting established accuracy.

20.3.7 Field Sampling Devices (ISCO Autosamplers)

Each autosampler (ISCO) is assigned a unique identification number in order to keep track of the calibration. This number is recorded on the sampling documentation in a logbook.

The autosampler is calibrated semi-annually by setting the sample volume to 100ml and recording the volume received. The results are filed in a logbook/binder. The autosampler is programmed to run three cycles, and each of the three cycles is measured into a beaker to verify 100 ml are received.

If the RSD (Relative Standard Deviation) between the three cycles is greater than 20%, the procedure is repeated. If the result is still greater than 20%, the following options may be employed:

- 1) The unit is taken out of service.
- 2) The unit is used to pull composite samples only over a 24-hour period.

The results of this check are kept in a logbook/binder.

20.4 INSTRUMENT CALIBRATIONS

Calibration of analytical instrumentation is essential to the production of quality data. Strict calibration procedures are followed for each method. These procedures are designed to determine and document the method detection limits, the working range of the analytical instrumentation and any fluctuations that may occur from day to day.

Sufficient raw data records are retained to allow an outside party to reconstruct all facets of the initial calibration. Records contain, but are not limited to, the following: calibration date, method, instrument, analyst(s) initials or signatures, analysis date, analytes, concentration, response, type of calibration (Avg RF, curve, or other calculations that may be used to reduce instrument responses to concentration.)

Sample results must be quantitated from the initial calibration and may not be quantitated from any continuing instrument calibration verification unless otherwise required by regulation, method or program.

If the initial calibration results are outside of the acceptance criteria, action is performed and any affected samples are re-analyzed if possible. If the re-analysis is not possible, any data associated with an unacceptable initial calibration must be reported with appropriate data qualifiers (refer to Section 12). For the Ohio EPA Voluntary Action Program (VAP), please refer to the SOPs for the acceptable criteria, corrective actions, and exceptions.

Note: Instruments are calibrated initially and as needed after that and at least annually.

20.4.1 CALIBRATION STANDARDS

Calibration standards are prepared using the procedures indicated in the Reagents and Standards section of the determinative method SOP.

Standards for instrument calibration are obtained from a variety of sources. All standards are traceable to national or international standards of measurement, or to national or international standard reference materials.

The lowest concentration calibration standard that is analyzed during an initial calibration must be at or below the stated reporting limit for the method based on the final volume of extract (or sample).

The other concentrations define the working range of the instrument/method or correspond to the expected range of concentrations found in actual samples that are also within the working range of the instrument/method. Results of samples not bracketed by initial instrument calibration standards (within calibration range to 3 significant figures) must be reported as having less certainty, e.g., defined qualifiers or flags (additional information may be included in the case narrative). The exception to these rules is ICP methods or other methods where the referenced method does not specify two or more standards.

All initial calibrations are verified with a standard obtained from a second source and traceable to a national standard, when available (or vendor certified different lot if a second source is not available). For unique situations, such as air analysis where no other source or lot is available, a standard made by a different analyst would be considered a second source. This verification occurs immediately after the calibration curve has been analyzed, and before the analysis of any samples.

20.4.2 Calibration Verification

The calibration relationship established during the initial calibration must be verified at initially and at least daily as specified in the laboratory method SOPs in accordance with the referenced analytical methods and NELAC (2003) standard, Section 5.5.5.10. The process of calibration verification applies to both external standard and internal standard calibration techniques, as well as to linear and non-linear calibration models.

Note: The process of calibration verification referred to is fundamentally different from the approach called "calibration" in some methods. As described in those methods, the calibration factors or response factors calculated during calibration are used to update the calibration factors or response factors used for sample quantitation. This approach, while employed in other EPA programs, amounts to a daily single-point calibration.

All target analytes and surrogates, including those reported as non-detects, must be included in periodic calibration verifications for purposes of retention time confirmation and to demonstrate that calibration verification criteria are being met.

All samples must be bracketed by periodic analyses of standards that meet the QC acceptance criteria (e.g., calibration and retention time). The frequency is found in the determinative methods or SOPs.

Note: If an internal standard calibration is being used (basically GCMS), then bracketing standards are not required. Only daily verifications are needed. The results from these verification standards must meet the calibration verification criteria and the retention time criteria (if applicable).

Generally, the initial calibrations must be verified at the beginning of each 12-hour analytical shift during which samples are analyzed. (Some methods may specify more or less frequent verifications). The 12-hour analytical shift begins with the injection of the calibration verification standard (or the MS tuning standard in MS methods). The shift ends after the completion of the analysis of the last sample or standard that can be injected within 12 hours of the beginning of the shift.

A continuing instrument calibration verification (CCV) must be repeated at the beginning and, for methods that have quantitation by external calibration models, at the end of each analytical batch. Some methods have more frequent CCV requirements see specific SOPs. Most Inorganic methods require the CCV to be analyzed after every 10 samples or injections include matrix or batch QC samples.

Note: If an internal standard calibration is being used (basically GCMS) then bracketing standards are not required, only daily verifications are needed. The results from these verification standards must meet the calibration verification criteria and the retention time criteria (if applicable).

20.4.2.1 Verification of Linear Calibrations

Calibration verification for linear calibrations involves the calculation of the percent drift or the percent difference of the instrument response between the initial calibration and each subsequent analysis of the verification standard. (These calculations are available in the laboratory method SOPs.) Verification standards are evaluated based on the % Difference from the average CF or RF of the initial calibration or based on % Drift or % Recovery if a linear or quadratic curve is used.

Regardless of whether a linear or non-linear calibration model is used, if initial verification criterion is not met, then no sample analyses may take place until the calibration has been verified or a new initial calibration is performed that meets the specifications listed in the method SOPs. If the calibration cannot be verified after the analysis of a single verification standard, then adjust the instrument operating conditions and/or perform instrument maintenance, and analyze another aliquot of the verification standard. If the calibration cannot be verified with the second standard, then a new initial calibration is performed.

When the acceptance criteria for the calibration verification are exceeded high, i.e., high bias, and there are associated samples that are non-detects, then those non-detects may be reported. Otherwise, the samples affected by the unacceptable calibration verification shall be reanalyzed after a new calibration curve has been established, evaluated and accepted.

When the acceptance criteria for the calibration verification are exceeded low, i.e., low bias, those sample results may be reported if they exceed a maximum regulatory limit/decision level. Otherwise, the samples affected by the unacceptable verification shall be reanalyzed after a new calibration curve has been established, evaluated and accepted. For Ohio VAP samples, results may not be reported when calibration verifications are exceeded low.

20.5 TENTATIVELY IDENTIFIED COMPOUNDS (TICS) – GC/MS ANALYSIS

For samples containing components not associated with the calibration standards, a library search may be made for the purpose of tentative identification. The necessity to perform this

type of identification will be determined by the purpose of the analyses being conducted. Data system library search routines should not use normalization routines that would misrepresent the library or unknown spectra when compared to each other.

Note: If the TIC compound is not part of the client target analyte list but is calibrated by the laboratory and is both qualitatively and/or quantitatively identifiable, it should not be reported as a TIC. If the compound is reported on the same form as true TICs, it should be qualified and/or narrated that the reported compound is qualitatively and quantitatively (if verification in control) reported compared to a known standard that is in control (where applicable).

For example, the RCRA permit or waste delisting requirements may require the reporting of non-target analytes. Only after visual comparison of sample spectra with the nearest library searches may the analyst assign a tentative identification.

20.6 GC/MS TUNING

Prior to any GCMS analytical sequence, including calibration, the instrument parameters for the tune and subsequent sample analyses within that sequence must be set.

Prior to tuning/auto-tuning the mass spec, the parameters may be adjusted within the specifications set by the manufacturer or the analytical method. These generally don't need any adjustment but it may be required based on the current instrument performance. If the tune verification does not pass it may be necessary to clean the source or perform additional maintenance. Any maintenance is documented in the maintenance log.

Table 20-1. Laboratory Equipment and Instrumentation

Instrument Type	Manufacturer	Model/Serial No.	Year into Service
GC/MS Volatiles	Hewlett-Packard (UX2)	5971A-5890, S/N 3140A38490	1992
	Hewlett-Packard (HP6)	5973-6890, S/N US00005571	2006
	Hewlett-Packard (UX7)	5973-6890, S/N US00010937	1998
	Hewlett-Packard (UX8)	5973-6890, S/N US00027773	1999
	Hewlett-Packard (UX9)	5973-6890, S/N US00028329	2000
	Hewlett-Packard (UX10)	5973-6890, S/N US00032072	2000
	Agilent (UX11)	5973-6890, S/N US00038093	2000
	Agilent (UX12)	5973-6890, S/N US10202133	2002
	Agilent (UX14)	5973-6890, S/N CN10340027	2003
	Agilent (UX15)	5973-6890, S/N CN10515062	2005
	Agilent (UX16)	5975-6890, S/N CN10539065	2005
GC/MS Volatiles Autosampler	OI Analytical (UX2)	4552	1999
	OI Analytical (HP6)	4552	1998
	OI Analytical (UX7)	4552	1998
	OI Analytical (UX8)	4552	1999
	OI Analytical (UX9)	4552	2000
	OI Analytical (UX10)	4552	2000
	OI Analytical (UX11)	4552	2000
	OI Analytical (UX12)	4552	2002
	OI Analytical (UX14)	4552	2003
	OI Analytical (UX15)	4552	2005
	OI Analytical (UX16)	4552	2005
GC/MS Volatiles Purge and Trap	OI Analytical (UX2)	4560	1999
	OI Analytical (HP6)	Encon	1998
	OI Analytical (UX7)	4660	2004
	OI Analytical (UX8)	4560	2004
	OI Analytical (UX9)	4560	2000
	OI Analytical (UX10)	4660	2003
	OI Analytical (UX11)	4560	2000
	OI Analytical (UX12)	4560	2002
	OI Analytical (UX14)	4560	2003
	OI Analytical (UX15)	4660	2005

Instrument Type	Manufacturer	Model/Serial No.	Year into Service
	OI Analytical (UX16)	4660	2005
	EST (spare)	4560	2002
GC/MS Semivolatiles	Hewlett-Packard HP7	5973-6890, S/N US00009247	1998
	Hewlett-Packard HP8	5973-6890, S/N US00022627	1999
	Hewlett-Packard HP9	5973-6890, S/N US00027943	2000
	Agilent HP10	5973-6890, S/N CN10340002	2003
	Agilent A4AG2	5975-C, S/N CN10721110	2007
GC Volatiles	Agilent (A)	6890 PID/FID, S/N US10402056	2004
	Hewlett-Packard (O)	6890 Dual PID/Hall, S/N US00007206	1997
	Hewlett-Packard (P)	6890 PID/HALL, S/N US00030616	1997
	Hewlett-Packard (Y)	6890N PID/FID, S/N US10337062	2003
	Agilent (Z)	6890 EPC & PDD/FID, S/N 10205072	2000
	Agilent (N)	7890 Atomic Fluorescence, S/N CN10820009	2008
GC Volatiles Auto Sampler	OI Analytical (O)	Archon	2000
	OI Analytical (Y)	4552	1998
	Varian (A)	Archon	1998
	Varian (P)	4552	2000
	Agilent (Z)	7694	2000
	EST (N)	Centurion	2008
GC Volatiles Purge & Trap	Tekmar (O)	4560	2000
	Tekmar (P)	3000	1993
	OI Analytical (A)	4560	1998
	OI Analytical (Y)	3000	1993
	Tekmar (N)	Stratum	2008
GC Semivolatiles	Hewlett-Packard (P1)	6890 EPC & Dual ECD Y-Splitter S/N US00023208	1998
	Hewlett-Packard (P2)	6890 EPC & Dual ECD Y-Splitter S/N US00023512	1998
	Hewlett-Packard (P3)	6890 EPC & Dual ECD Y-Splitter S/N US00023674	1998
	Hewlett-Packard (P4)	6890 EPC & Dual ECD Y-Splitter S/N US00029531	1999
	Hewlett-Packard (P6)	6890 EPC & Dual FID S/N US00032848	2000

Instrument Type	Manufacturer	Model/Serial No.	Year into Service
	Agilent (P7)	6890N EPC & Dual FID S/N US10202132	2000
	Agilent (P9)	6890N EPC & Dual ECD Y-Splitter S/N US10205045	2005
	Agilent (P10)	6890 EPC & Dual ECD Y-Splitter S/N US10151110	1999
	Agilent (P11)	6890N EPC & Dual ECD Y-Splitter S/N CN10517088	2004
	Agilent (P12)	6890N EPC & Dual ECD Y-Splitter S/N CN10512025	2005
	Agilent (P13)	6890N EPC & Dual ECD Y-Splitter S/N CN10435032	2004
GC Semivolatiles HPLC	Hewlett-Packard (L2)	HPLC 1100, S/N US82404153	1998
Extractions Sonicators	Misonix	3000 (self-tuning), S/N R1044	2005
	Misonex	Ultrasonic Processor XL, S/N G4221	
	Heat Systems	XL2020, S/N G1026	2001
Extractions 6-Position Accelerated Soxhlet Extractor	Gerhardt Soxtherm	8 units	2003
Extractions pH Meter	Thermo Orion	420, S/N 074028	1998
	Mettler Toledo	SevenEasy pH (self-calibrating) S/N 1228295055	2008
	Denver Instrument (spare)	UB-5 S/N UB-5093011	2004
Metals ICP	Thermo Jarrell Ash (I-5)	Trace Analyzer 61E, S/N 273490	1994
	Thermo Jarrell Ash (I-6)	Trace Analyzer 61E, S/N 269490	1994
Metals ICP/MS	Thermo (I-8)	Series 2, S/N 01137C	2007
Metals Mercury Analyzer	Leeman (CVAA) (H1)	PS200 II, S/N HG9031	1999
	Leeman (CVAF) Low Level (H3)	Hydra AF Gold+, Model #112-00067-1 S/N AFG1006	2001
	Leeman (CVAA) (H4)	Hydra AA, S/N 6011	2006
WC Arsenic Speciation	Trace Detect	Nano-Band Explorer, S/N NBE00017	2003
WC Autotitrator	Man-Tech	PC – Titrate, S/N MS-9K8-217	2001

Instrument Type	Manufacturer	Model/Serial No.	Year into Service
WC Block Digester	Andrews	2210 Phenol	1999
	Andrews	2205 Ammonia	1999
	Lachat	BD46 TKN	1992
WC BOD	Mantech	BOD, S/N N817947	1999
WC Conductivity	Man-Tech	4310, S/N 1613	1989
WC Cyanide	LabCrest MidiDist	PRG-2520-BL, S/N 1000-99-01	1999
WC Discrete Analyzer	Kone	Konelab 200, Z1718383	2001
	Kone	Konelab 250, A2120021	2005
WC Dissolved Oxygen Meter	YSI	52C E, S/N 99C1094	1993
WC Flashpoint	Herzog	HFP 339, S/N 073390084	2007
	Petrolab (199443)	Petrotest, S/N 0741990603	1999
WC Ion Chromatograph	Dionex	DX-320, S/N 00060187	2001
	Dionex	DX-120, S/N 98110093	1999
WC pH Meter	Orion pH Meter	320, S/N 020032	2007
	Orion (Ammonia ISE)	520A, S/N 48029	1996
WC Residual Chlorine Meter	Hanna	HI 93701	2000
	Hanna	HI 93701	2006
WC TOC	OI Analytical	1010 TOC Analyzer, S/N K503710931	2005
WC TOX	Thermo Electron	1200, S/N 973515	1998
	Thermo Electron	1200, S/N 2001.0174	2005
	Thermo Electron	1200, S/N 2005.0234	2005
WC TRAACS	Bran & Luebbe	800, S/N 890140	1993
WC Turbidimeter	HF Scientific	Micro 100, S/N 200705143	2001
WC UV / VIS	Milton Roy	Spectronic 401, S/N 381A170002	1993
	Genesys	Spectronic 20, S/N 3SGL078016	1998
	Genesys	Spectronic 20, S/N 3SCA174040	2008
	Genesys	Spectronic 20, S/N 3SGL226006 (Model 4001/4)	2008
WC Sulfide	Westco EasyDist		2008

Table 20-2. Schedule of Routine Maintenance

(Refer to manufacturer's instructions for each instrument to identify and perform maintenance operations)

**INSTRUMENT MAINTENANCE SCHEDULE
ION CHROMATOGRAPH**

As Needed	Daily	Weekly	Monthly
Clean micro-membrane suppressor when decreases in sensitivity are observed.	Check plumbing/leaks.	Check pump heads for leaks.	Check all air and liquid lines for discoloration and crimping, if indicated.
Check fuses when power problems occur.	Check gases.	Check filter (inlet)	Check/change bed supports guard and analytical columns, if indicated.
Reactivate or change column when peak shape and resolution deteriorate or when retention time shortening indicates that exchange sites have become deactivated.	Check pump pressure.		
De-gas pump head when flow is erratic.	Check conductivity meter.		

**INSTRUMENT MAINTENANCE SCHEDULE
TOTAL ORGANIC HALIDE ANALYZER**

Daily	As Needed
Check electrodes for damage; polish the electrodes.	Examine and clean or replace pyrolysis tube.
Replace dehydrating fluid and electrolyte fluid.	Clean titration cell.
Clean quartz boat.	Observe gas flow.
Observe check valves during use for backfeed.	Replace reference electrode fluid.
At end of each day of use, wash out absorption module, empty electrolyte and fill cell with DI water. Empty dehydrator tube	Change quartz wool.
Perform cell performance check.	Replace O-rings and seals.

**INSTRUMENT MAINTENANCE SCHEDULE
HIGH PRESSURE LIQUID CHROMATOGRAPH**

Daily	As Needed
Check level of solution in reservoirs. If adding, verify that solvent is from the same source. If changing, rinse gas and delivery lines to prevent contamination of the new solvent.	Replace columns when peak shape and resolution indicate that chromatographic performance of column is below method requirements.
Check gas supply.	Oil autosampler slides when sample does not advance.
Flush with an appropriate solvent to remove all bubbles.	Rinse flow cell with 1N nitric acid if sensitivity low.
Pre-filter all samples.	Change pump seals when flow becomes inconsistent.
	Repack front end of column Backflush column.

**INSTRUMENT MAINTENANCE SCHEDULE
ICP AND ICP/MS**

Daily	Monthly or As Needed	Semi-Annually	Annually
Check vacuum pump gage. (<10 millitorr)	Clean plasma torch assembly to remove accumulated deposits	Change vacuum pump oil	Notify manufacturer service engineer for scheduled preventive maintenance service
Check cooling water supply system is full and drain bottle is not full. Also drain tubing is clear, tight fitting, and has few bends.	Clean nebulizer and drain chamber; keep free flowing to maintain optimum performance	Replace coolant water filter (may require more or less frequently depending on quality of water)	
Check nebulizer is not clogged	Clean filters on back of power unit to remove dust		
Check capillary tubing is clean and in good condition	Replace when needed: - peristaltic pump tubing - sample capillary tubing - autosampler sipper probe		
Check peristaltic pump windings are secure	- Check yttrium position - Check O-rings - Clean/lubricate pump rollers		
Check high voltage switch is on			
Check torch, glassware, aerosol injector tube, and bonnet are clean			

**INSTRUMENT MAINTENANCE SCHEDULE
CVAS AND CVAFS**

Daily	As Needed	Annually
Change drying tube	Change pump tubing	Change Hg lamp
Check pump tubing/drain tubing	Check/change Hg lamp	
Check gas pressure	Clean optical cell	
Check aperture reading Check tubing	Lubricate pump	

**INSTRUMENT MAINTENANCE SCHEDULE
GAS CHROMATOGRAPH**

Daily *	As Needed
Check for sufficient supply of carrier and detector gases. Check for correct column flow and/or inlet pressures.	Replace front portion of column packing or break off front portion of capillary columns. Replace column if this fails to restore column performance, or when column performance (e.g., peak tailing, poor resolution, high backgrounds, etc.) indicates it is required. Quarterly FID: clean detector, only as needed—not quarterly/or semi-annually.
Check temperatures of injectors and detectors. Verify temperature programs by RT shift.	Change glass wool plug in injection port and/or replace injection port liner when front portion of column packing is changed or front portion of capillary column is removed.
Clean injector port weekly for TPH for 8015B, when breakdown fails; otherwise, when RT shift or bad samples run.	Annually FID: replace flame tip, only as needed. Only as needed: ECD--detector cleaning and re-foiling, whenever loss of sensitivity, erratic response, or failing resolution is observed
Check baseline level during analysis of run—not maintenance.	Perform gas purity check (if high baseline indicates that impure carrier gas may be in use).
Watched weekly: check reactor temperature of electrolytic conductivity detector. Inspect chromatogram to verify symmetrical peak shape and adequate resolution between closely eluting peaks, when analyzing pesticides; part of analysis—not maintenance. Clip column leader when chromatography looks bad—not daily.	Replace or repair flow controller if constant gas flow cannot be maintained. Replace fuse. Reactivate external carrier gas dryers. Detectors: clean when baseline indicates contamination or when response is low. FID: clean/replace jet, replace ignitor. ECD: follow manufacturer's suggested maintenance schedule. Reactivate flow controller filter dryers when presence of moisture is suspected. HP 7673 Autosampler: replace syringe, fill wash bottle, dispose of waste bottle contents.

*No daily maintenance done on any instrument/method. Weekly change IPL on TPH instrument. Everything else is on an "as needed" basis.

**INSTRUMENT MAINTENANCE SCHEDULE
MASS SPECTROMETER**

Daily	Weekly	As Needed	Quarterly	Annually
Check for sufficient gas supply. Check for correct column flow and/or inlet pressure.	Check mass calibration (PFTBA or FC-43)	Check level of oil in mechanical pumps and diffusion pump if vacuum is insufficient. Add oil if needed between maintenance.	Check ion source and analyzer (clean, replace parts as needed)	Replace the exhaust filters on the mechanical rough pump every 1-2 years.
Check temperatures of injector, detector. Verify temperature programs.		Replace electron multiplier when the tuning voltage approaches the maximum and/or when sensitivity falls below required levels.	Check vacuum, relays, gas pressures and flows	
Check inlets, septa		Clean Source, including all ceramics and lenses - the source cleaning is indicated by a variety of symptoms including inability of the analyst to tune the instrument to specifications, poor response, and high background contamination.	Change oil in the mechanical rough pump.	
Check baseline level		Repair/replace jet separator.		
Check values of lens voltages, electron multiplier, and relative abundance and mass assignments of the calibration compounds.		Replace filaments when both filaments burn out or performance indicates need for replacement.		

**INSTRUMENT MAINTENANCE SCHEDULE
TRAACS AUTO ANALYZER**

As Needed	Daily
Replaces air filter when progressive loss of air pressure is observed.	Check air pressure gauge (22 ± 2 psi)
Replace air valve tubing when occlusion in tubing is observed	Use recommended washout procedure (at end of analysis operations)
Change all pump tubes (or after 200 hours of pumping time, or after 1000 hours of pumping time)	
Clean sample probe shaft	
Replace pump platens	
Lightly lubricate the linear sample rails (use semi-fluid lubricant)	
Replace colorimeter lamp (or after 2500 hours of use)	

**INSTRUMENT MAINTENANCE SCHEDULE
ANALYTICAL/TOP LOADING BALANCES**

Daily	Annually
Check using Class 1-verified weights once daily or before use	Manufacturer cleaning and calibration
Clean pan and weighing compartment	

**INSTRUMENT MAINTENANCE SCHEDULE
REFRIGERATORS/WALK-IN COOLERS**

Daily	As Needed
Temperatures checked and logged	Refrigerant system and electronics serviced

**INSTRUMENT MAINTENANCE SCHEDULE
OVENS**

Daily	As Needed
Temperatures checked and logged	Electronics serviced

**INSTRUMENT MAINTENANCE SCHEDULE
SPECIFIC DIGITAL ION ANALYZER**

Daily	As Needed
Daily when used: <ul style="list-style-type: none"> • Calibrate with check standards • Inspect electrode daily, clean as needed • Inspect electrode proper levels of filling solutions daily; fill as needed • Clean probe after each use 	Electronics serviced

**INSTRUMENT MAINTENANCE SCHEDULE
TURBIDIMETER**

Daily	Monthly	As Needed
Daily when used: <ul style="list-style-type: none"> • Adjust linearity on varying levels of NTU standards. Standardize with NTU standards • Inspect cells 	Clean instrument housing	Electronics serviced

**INSTRUMENT MAINTENANCE SCHEDULE
DISSOLVED OXYGEN METER**

Daily	As Needed
Daily when used: <ul style="list-style-type: none"> • Calibrate with saturated air • Check probe membrane for deterioration • Clean and replace membrane with HCl solution 	<ul style="list-style-type: none"> • Electronics serviced • Clean and replace membrane with HCl solution

**INSTRUMENT MAINTENANCE SCHEDULE
CONDUCTANCE METER**

Daily	As Needed
Daily when used: <ul style="list-style-type: none"> Check probe and cables Inspect conductivity cell 	Electronics serviced

**INSTRUMENT MAINTENANCE SCHEDULE
CHEMICAL OXYGEN DEMAND (COD) REACTOR ¹**

Daily	As Needed
Daily when used: <ul style="list-style-type: none"> Calibrate with check standards 	Electronics serviced

**INSTRUMENT MAINTENANCE SCHEDULE
SPECTROPHOTOMETER**

As Needed	Daily	Monthly	Annually
Dust the lamp and front of the front lens	Check the zero % adjustment	Clean windows	Check instrument manual
	Clean sample compartment		Perform wavelength calibration
	Clean cuvettes		Replace lamp annually or when erratic response is observed
			Clean and align optics

**INSTRUMENT MAINTENANCE SCHEDULE
pH METER**

As Needed	Daily
Clean electrode	Inspect electrode. Verify electrodes are properly connected and filled
Refill reference electrode	Inspect electrode proper levels of filling solutions. Make sure electrode is stored in buffer

**INSTRUMENT MAINTENANCE SCHEDULE
TOTAL ORGANIC CARBON ANALYZER**

Daily	As Needed	Weekly	Monthly
Check: <ul style="list-style-type: none"> • Oxygen supply • Persulfate supply • Acid supply • Carrier gas flow rate (~ 150 cc/min) • IR millivolts for stability (after 30 min. warm-up) • Reagent reservoirs 	Check injection port septum after 50-200 runs Tube end-fitting connections after 100 hours or use Indicating drying tube NDIR zero, after 100 hours of use Sample pump, after 2000 hours for use Digestion vessel/condensation chamber, after 2000 hours of use Permeation tube, after 2000 hours of use NDIR cell, after 2000 hours of use Change pump tubing	Check liquid-flow-rate-pump-tubing conditions on autosampler Check injection port septum	Clean digestion vessel Clean condenser column Do the leak test

**Instrument Maintenance Schedule
Digestion Block**

Annually
Check temperature with NIST thermometer

**Instrument Maintenance Schedule
Flash Point Tester**

Daily
Check tubing Clean sample cup each use
Check gas
Clean flash assembly
Check stirrer

Table 20-3. Preventive Maintenance Procedures

SUMMARY OF INORGANIC METHOD CALIBRATIONS

Analysis	Calibration	NPDES ¹		RCRA (SW846) ²	
		Method	Requirement	Method	Requirement
Acidity	Initial	350.1	Two-level calibration that bracket the expected pH of the sample ± 0.05 pH units of true value	9040B 9045C	2 point calibration ± 0.05 pH units of true value
	Continuing	350.1	One buffer check every 10 samples ± 5% of true value	9040B 9045C	N/A
	Other	350.1	Third point check	9040B 9045C	Third point check
	Ending	350.1	One buffer check ± 5% of true value	9040B 9045C	N/A
Alkalinity, Bicarbonate, Carbonate	Initial	310.1 2320B	2 point calibration of pH meter ± 0.05 pH units of true value	--	N/A
	Continuing	310.1 2320B	N/A	--	N/A
	Ending	310.1 2320B	N/A	--	N/A
Ammonia	Initial	350.1	6 levels including blank, "r" ³ ≥ 0.995	--	N/A
	Continuing	350.1	One level or LCS every 10 samples ± 10% of true value	--	N/A
	Ending	350.1	One level or LCS every 10 samples ± 10% of true value	--	N/A
Arsenic Speciation		N/A	N/A	7063	* Refer to Section 10 of SOP NC-WC-0090

Analysis	Calibration	NPDES ¹		RCRA (SW846) ²	
		Method	Requirement	Method	Requirement
Biochemical Oxygen Demand (BOD)	Initial	405.1 SM5210B	a. Winkler titration: Iodometric with standard thiosulfate b. Membrane electrode: Read in air and in water with zero dissolved oxygen	--	N/A
	Continuing	405.1 SM5210B	N/A	--	N/A
	Ending	405.1 SM5210B	N/A	--	N/A
Bromide	Initial	300.0A	5 levels plus a blank, " r " ³ ≥ 0.995	9056A	5 levels plus a blank, " r " ³ ≥ 0.995
	Continuing	300.0A	Level every 10 samples $\pm 10\%$ of true value	9056A	N/A
	Ending	300.0A	N/A	9056A	N/A
Cation Exchange	Initial	N/A	N/A	9081	N/A
	Continuing	N/A	N/A	9081	N/A
	Ending	N/A	N/A	9081	N/A
Chemical Oxygen Demand (COD)	Initial	410.4 SM5220D	5 levels plus a blank" r " ³ ≥ 0.995	--	N/A
	Continuing	410.4 SM5220D	One level every 10 samples $\pm 10\%$ of true value	--	N/A
	Ending	410.4 SM5220D	One level $\pm 10\%$ of true value	--	N/A

Analysis	Calibration	NPDES ¹		RCRA (SW846) ²	
		Method	Requirement	Method	Requirement
Chloride	Initial	300.0A 325.2	5 levels plus blank "r" ³ ≥ 0.995	9056A 9251	Method 9056: 3 levels plus a blank Method 9252: 5 levels plus blank "r" ³ ≥ 0.995
	Continuing	300.0A 325.2	One level every 10 samples ± 10% of true value	9056A 9251	Method 9056: One per batch of 20 samples, ± 10% of true value Method 9252: One level every 10 samples, ± 10% of true value
	Ending	300.0A 325.2	One level every 10 samples ± 10% of true value	9056A 9251	Method 9056 : N/A Method 9252: One level ± 10% of true value
Chromium Cr ⁺⁶	Initial	3500 Cr-D	3 levels plus blank	7196A	5 levels plus blank "r" ³ ≥ 0.995
	Continuing	3500 Cr-D	One level every 10 samples ± 10% of true value	7196A	One level every 10 samples ± 15%
	Ending	3500 Cr-D	One level ± 10% of true value	7196A	One level ± 15%
Chlorine, Residual	Initial	330.5 SM3500CL-G	N/A	--	N/A
	Continuing	330.5 SM3500CL-G	N/A	--	N/A
	Ending	330.5 SM3500CL-G	N/A	--	N/A

Analysis	Calibration	NPDES ¹		RCRA (SW846) ²	
		Method	Requirement	Method	Requirement
Conductivity	Initial	120.1 SM2510B	Standard KCl solution	9050A	One level to determine cell constant
	Continuing	120.1 SM2510B	N/A	9050A	N/A
	Ending	120.1 SM2510B	N/A	9050A	N/A
Cyanide (Amenable)	Initial	335.1 SM4500CN-G	6 levels plus blank "r" ³ ≥ 0.995	9012A	6 levels plus blank "r" ³ ≥ 0.995
	Continuing	335.1 SM4500CN-G	One level every 10 samples ± 10% of true	9012A	One mid-level every 10 samples ± 15% of true value
	Ending	335.1 SM4500CN-G	One level ± 10 % of true value	9012A	± 15% of true value
Cyanide (Total)	Initial	335.1/335.2 335.3/335.4 SM4500CU-E/ 335.2-CLP-M	6 levels plus blank "r" ³ ≥ 0.995	9012A	6 levels plus blank "r" ³ ≥ 0.995
	Continuing	335.1/335.2 335.3/335.4 SM4500CU-E/ 335.2-CLP-M	One mid-level every 10 samples ± 10 % of true value	9012A	One mid-level every 10 samples ± 15% of true value
	Ending	335.1/335.2 335.3/335.4 SM4500CU-E/ 335.2-CLP-M	One mid-level ± 10 % of true value	9012A	± 15% of true value
Flashpoint	Initial	--	N/A	1010 ASTM D93-9	p-Xylene reference standard must have flashpoint of 81°F ±2°F
	Continuing	--	N/A	1010 ASTM D93-9	N/A
	Ending	--	N/A	1010 ASTM D93-9	N/A

Analysis	Calibration	NPDES ¹		RCRA (SW846) ²	
		Method	Requirement	Method	Requirement
Fluoride	Initial	300.0A 340.2	Method 300.0A: 5 levels plus a blank, "r" ³ ≥ 0.995 Method 340.2: 5 levels "r" ³ ≥ 0.995	9056A	3 levels plus a blank
	Continuing	300.0A 340.2	One mid-level every 10 samples ± 10% of true value	9056A	One per batch of 20 samples ± 10% of true value
	Ending	300.0A 340.2	One mid-level ± 10% of true value	9056A	N/A
Hardness	Initial	130.2 2340B	Method 130.2: Standardize titrant Method 2340B: See ICP Metals 200.7	--	N/A
	Continuing	130.2 2340B	Method 130.2: N/A Method 2340B: See ICP Metals 200.7	--	N/A
	Ending	130.2 2340B	Method 130.2: N/A Method 2340B: See ICP Metals 200.7	--	N/A
Iron (Ferrous)	Initial	3500-Fe D	3 levels plus a blank, "r" ³ ≥ 0.995	-	N/A
	Continuing	3500-Fe D	One mid-level every 10 samples ± 10% of true value	-	N/A
	Ending	3500-Fe D	One mid-level ± 10% of true value	-	N/A

Analysis	Calibration	NPDES ¹		RCRA (SW846) ²	
		Method	Requirement	Method	Requirement
Nitrate	Initial	300.0A 353.2 SM4500NO ₃ -E	5 levels plus a blank "r" ³ ≥ 0.995	9056A	3 levels plus a blank
	Continuing	300.0A 353.2 SM4500NO ₃ -E	One mid-level every 10 samples ± 10% of true value	9056A	One per batch of 20 samples ± 10% of true value
	Ending	300.0A 353.2 SM4500NO ₃ -E	One mid-level ± 10% of true value	9056A	N/A
Nitrite	Initial	300.0A 354.1	5 levels plus a blank "r" ³ ≥ 0.995	9056A	3 levels plus a blank
	Continuing	300.0A 354.1	One mid-level every 10 samples ± 10% of true value	9056A	One per batch of 20 samples ± 10% of true value
	Ending	300.0A 354.1	One mid-level ± 10% of true value	9056A	N/A
Nitrate-Nitrite	Initial	300.0A 353.2	5 levels plus blank "r" ³ ≥ 0.995	--	N/A
	Continuing	300.0A 353.2	One level every 10 samples ± 10% of true value	--	N/A
	Ending	300.0A 353.2	One mid-level ± 10% of true value	--	N/A

Analysis	Calibration	NPDES ¹		RCRA (SW846) ²	
		Method	Requirement	Method	Requirement
Phosphorus (Total and Ortho-phosphate)	Initial	300.0A 365.1 SM4500P-E	Method 300.0A/365.3: 3 levels plus a blank Method 365.2: 5 levels plus a blank	--	N/A
	Continuing	300.0A 365.1 SM4500P-E	Method 300.0A/365.3: One level every 10 samples ± 10% of true value Method 365.2: Blank and 2 standards with each series of samples, ± 2% of true value or recalibrate	--	N/A
	Ending	300.0A 365.1 SM4500P-E	Method 300.0A/365.3: ± 10% of true value Method 365.2: N/A	--	N/A
pH	Initial	150.1 SM4500H-B	2 level calibration that bracket the expected pH of the sample ± 0.05 pH units of true value	9040B 9045C	2 point calibration ± 0.05 pH units of true value
	Continuing	150.1 SM4500H-B	One buffer check every 10 samples ± 5% of true value	9040B 9045C	N/A
	Other	150.1 SM4500H-B	Third point check	9040B 9045C	Third point check
	Ending	150.1 SM4500H-B	One buffer check ± 5% of true value	9040B 9045C	N/A

Analysis	Calibration	NPDES ¹		RCRA (SW846) ²	
		Method	Requirement	Method	Requirement
Phenolics	Initial	420.1	5 levels plus a blank "r" ³ ≥ 0.995	9065 9066	5 levels plus a blank "r" ³ ≥ 0.995
	Continuing	420.1	One mid-level every 10 samples ± 10% true value	9065 9066	One mid-level ± 15% true value
	Ending	420.1	One mid-level ± 10% true value	9065 9066	One mid-level ± 15% true value
Phosphate	Initial	SM4500P-E	N/A	9056	3 levels plus a blank
	Continuing	SM4500P-E	N/A	9056	One per batch of 20 samples ± 15% of true value
	Ending	SM4500P-E	N/A	9056	N/A
Settleable Solids	Initial	160.5	N/A	--	N/A
	Continuing	160.5	N/A	--	N/A
	Ending	160.5	N/A	--	N/A
Specific Conductance	Initial	120.1 SM2510B	Standardize meter with 0.01 M KCl	9050A	N/A
	Continuing	120.1 SM2510B	One level every 10 samples ± 10% of true value	9050A	N/A
	Ending	120.1 SM2510B	One level ± 10% of true value	9050A	N/A
Sulfate	Initial	300.0A 375.4	Method 300.0A: 5 levels plus blank "r" ³ ≥ 0.995 Method 375.4: 3 levels plus blank "r" ³ ≥ 0.995	9038 9056A	Method 9038: 3 levels plus a blank for every hour of continuous sample analysis. Method 9056: 3 levels plus a blank

Analysis	Calibration	NPDES ¹		RCRA (SW846) ²	
		Method	Requirement	Method	Requirement
Sulfate (Cont'd)	Continuing	300.0A 375.4	<u>Method 300.0A:</u> One mid-level after every 10 samples ± 10% of true value <u>Method 375.4:</u> One level every 3 or 4 samples ± 10% of true value	9038 9056A	<u>Method 9038:</u> Independent-prepared check standard every 15 samples <u>Method 9056:</u> 1 per batch of 20 samples ± 10% of true value
	Ending	300.0A 375.4	± 10% of true value	9038 9056A	N/A
Sulfide	Initial	376.1	<u>Method 376.1:</u> This is a titration method. Therefore, calibrations are not applicable.	9030B/ 9034 9030A	This is a colorimetric titration. Therefore, calibration is not applicable.
	Continuing	376.1	<u>Method 376.1:</u> N/A	9030B/ 9034 9030A	This is a colorimetric titration. Therefore, calibration is not applicable.
	Ending	376.1	<u>Method 376.1:</u> N/A	9030B/ 9034 9030A	This is a colorimetric titration. Therefore, calibration is not applicable.
Total Dissolved Solids	Initial	160.1 SM2540E	This is a gravimetric determination. Calibrate balance prior to analysis	--	N/A
	Continuing	160.1 SM2540E		--	N/A
	Ending	160.1 SM2540E		--	N/A

Analysis	Calibration	NPDES ¹		RCRA (SW846) ²	
		Method	Requirement	Method	Requirement
Total Kjeldahl Nitrogen (TKN)	Initial	351.3 SM4500NO ₃	Method 351.3: Titrimetric: Standardize titrant Colorimetric: 7 levels plus blank	--	N/A
	Continuing	351.3 SM4500NO ₃	Method 351.3: N/A	--	N/A
	Ending	351.3 SM4500NO ₃	Method 351.3: N/A	--	N/A
Total Organic Carbon (TOC)	Initial	415.1 SM5310D	3 levels plus blank	9060 Walkley Black	3 levels plus blank "r" ³ ≥ 0.995
	Continuing	415.1 SM5310D	1 mid-level every 10 samples ± 15% of true value	9060 Walkley Black	1 mid-level every 10 samples ± 15% of true value
	Ending	415.1 SM5310D	± 15% of true value	9060 Walkley Black	± 15% of true value
Total Organic Halides (TOX)	Initial	450.1	Method 450.1: Daily instrument calibration standard and blank in duplicate ± 10% of true value (calibration standard) Verify with independently- prepared check standard	9020B 9023 (EOX)	Daily instrument calibration standard and blank in duplicate ± 10% of true value (calibration standard) Verify with independently-prepared check standard –ICV ± 10% SOP CORP-WC- 0001

Analysis	Calibration	NPDES ¹		RCRA (SW846) ²	
		Method	Requirement	Method	Requirement
Total Organic Halides (TOX) (cont'd)	Continuing	450.1	± 10% of true value	9020B 9023 (EOX)	CCV ± 10% of true value SOP CORP-WC-0001
	Ending	450.1	± 10% of true value	9020B 9023 (EOX)	CCV ± 10% of true value SOP CORP-WC-0001
Total Solids	Initial	160.3	This is a gravimetric determination. Calibrate balance before use.	--	N/A
	Continuing	160.3		--	N/A
	Ending	160.3		--	N/A
Total Suspended Solids (Nonfilterable)	Initial	160.2 SM2540E	This is a gravimetric determination. Calibrate balance before use.	--	N/A
	Continuing	160.2 SM2540E		--	N/A
	Ending	160.2 SM2540E		--	N/A
Turbidity	Initial	180.1	Minimum of 1 level in each instrument range. Follow manufacturer's instructions	--	N/A
	Continuing	180.1	N/A	--	N/A
	Ending	180.1	N/A	--	N/A
Volatile Solids	Initial	160.4	This is a gravimetric determination. Calibrate balance before use.	--	N/A
	Continuing	160.4		--	N/A
	Ending	160.4		--	N/A

Analysis	Calibration	NPDES ¹		RCRA (SW846) ²	
		Method	Requirement	Method	Requirement
ICP & ICP/MS Metals (excludes Hg)	Initial	200.7	One level and blank. ICV RSD <3% from replicate - daily	6010B	One level and blank. ICV RSD <5% from replicate - daily
	Initial	200.8	One level and blank	6020	One level and blank
	Continuing	200.7	Every 10 samples $\pm 10\%$ of true value CCV RSD < 5% from replicate	6010B	Mid-level calibration standard Every 10 samples $\pm 10\%$ of true value CCV RSD < 5% from replicate
	Continuing	200.8	N/A	6020	N/A
	Ending	200.7	$\pm 10\%$ of true value CCV RSD < 5% from replicate	6010B	Mid-level calibration standard $\pm 10\%$ of true value CCV RSD < 5% from replicate
	Ending	200.8	N/A	6020	N/A
	Other	200.7	ICSA, ICSAB: Analyze at beginning of run. For ICSA, AB criteria see SOP Semi-Annually: ICP interelement correction factors Instrument detection limits	6010B	ICSA, ICSAB: Analyze at beginning of run. For ICSA, AB criteria see SOP Semi-Annually: ICP interelement correction factors Instrument detection limits
	Other	200.8	N/A	6020	N/A

Analysis	Calibration	NPDES ¹		RCRA (SW846) ²	
		Method	Requirement	Method	Requirement
Mercury by CVAA & CVAFS	Initial	245.1 1631E	5 levels plus blank ICV $\pm 10\%$ of true value " r " ³ ≥ 0.995	7470A 7471A	5 levels plus blank ICV $\pm 10\%$ of true value " r " ³ ≥ 0.995
	Continuing	245.1* 1631E	Daily or every 10 samples, whichever is more frequent $\pm 20\%$ of true value	7470A 7471A	Every 10 samples $\pm 20\%$ of true value
	Ending	245.1 1631E	$\pm 20\%$ of true value	7470A 7471A	$\pm 20\%$ of original prepared standard
	Other	245.1 1631E	<u>Annually:</u> MDL	7470A 7471A	<u>Annually:</u> MDL

* 245.1 continuing – Initial CCV $\pm 5\%$ of true value

Footnotes

¹ National Pollutant Discharge Elimination System.

² Resource Conservation and Recovery Act, Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, (SW-846), Third Edition, September 1986. Contains Final Update I (July 1992), Final Update IIA (August 1993), Final Update II (September 1994), Final Update IIB (January 1995), and Final Update III (December, 1996).

³ " r " = correlation coefficient.

SUMMARY OF ORGANIC METHOD CALIBRATIONS

Analysis	Calibration	NPDES ¹		RCRA (SW846) ²	
		Method	Requirement	Method	Requirement
Aromatic Volatiles by GC	Initial	602	Minimum of 3 levels If % RSD < 10%, use avg RF. Otherwise, calibration curve employed. Six levels for quadratic equation.	8021B	Minimum of 5 levels If % RSD < 20%, use avg RF. Otherwise, calibration curve employed. Six levels for quadratic equation.
	Continuing	602	Analyze QC check sample and evaluate per method requirements	8021B	Mid-level calibration standard analyzed every 10 injections or 12 hrs whichever is greater, % D ≤ 15%, gases 20% D. Evaluate per SOP
	Ending	602	Run closer per NELAC requirement, but no criteria	8021B	Mid-level calibration standard, % D ≤ 15%. Evaluate per SOP, except as noted above.
	Other	602	N/A	8021B	N/A
Herbicides by GC	Initial	615 ⁹	Minimum of 3 levels If % RSD < 10%, use avg RF. Otherwise, calibration curve employed	8151A	Minimum of 5 levels If % RSD < 20%, use avg RF. Otherwise, calibration curve employed.
	Continuing	615 ⁹	One or more calibration standards analyzed daily % D ± 15% of predicted response	8151A	Mid-level calibration standard analyzed every 10 samples. % D < 15% of predicted response for any analyte quantitated and reported.
	Ending	615 ⁹	N/A	8151A	Mid-level calibration standard. % D < 15% of predicted response for any analyte quantitated and reported.
	Other	615 ⁹	N/A	8151A	N/A

Analysis	Calibration	NPDES ¹		RCRA (SW846) ²	
		Method	Requirement	Method	Requirement
Pesticides/ PCBs by GC	Initial	608	Minimum of 3 levels If % RSD < 10%, use avg RF. Otherwise, calibration curve employed	8081A 8082	Minimum of 5 levels. If % RSD < 20%, use avg RF. Otherwise, calibration curve employed. (See SOP NC-GC-038)
	Continuing	608	One or more calibration standards analyzed daily. % D \pm 15% of predicted response	8081A 8082	Mid-level calibration standard analyzed every 10 samples. % D < 15% of predicted response for any analyte quantitated and reported.
	Ending	608	N/A	8081A 8082	Mid-level calibration standard. % D < 15% of predicted response for any analyte quantitated and reported.
	Other	608	N/A	8081A 8082	N/A
Petroleum Hydrocarbons/ Oil and Grease	Initial	1664A	Calibrate analytical balance at 2 mg and 1000 mg Calibration must be \pm 10% at 2 mg and \pm 0.5% at 1000 mg or recalibrate balance	9071B	Calibrate analytical balance at 2 mg and 1000 mg Calibration must be \pm 10% at 2 mg and \pm 0.5% at 1000 mg or recalibrate balance
	Continuing	1664A	N/A	9071B	N/A
	Ending	1664A	N/A	9071B	N/A

Analysis	Calibration	NPDES ¹		RCRA (SW846) ²	
		Method	Requirement	Method	Requirement
Purgeable Halocarbons by GC	Initial	601	Minimum of 3 levels If % RSD < 10%, use avg RF. Otherwise, calibration curve employed. Six levels for quadratic equation.	8021B	Minimum of 5 levels If % RSD < 20%, use avg RF. Otherwise, calibration curve employed. Six levels for quadratic equation.
	Continuing	601	Analyze QC check sample and evaluate per method requirements	8021B	Mid-level calibration standard analyzed every 10 injections, or 12 hrs, whichever is greater. % D < 15%, gases 20% D Evaluate per SOP
	Ending	601	Run per NELAC, but no requirement to meet	8021B	Mid-level calibration standard, % D <15%. Evaluate per SOP
	Other	601	N/A	8021B	N/A
Halogenated Volatiles by GC	Initial	--	N/A	8021B	Minimum of 5 levels If % RSD < 20%, use avg RF. Otherwise, calibration curve employed.
	Continuing	--	N/A	8021B	Mid-level calibration standard analyzed every 10 samples. % D < 15% of predicted response for any analyte quantitated and reported.
	Ending	--	N/A	8021B	Mid-level calibration standard % D < 15% of predicted response for any analyte quantitated and reported.
	Other	--	N/A	8021B	N/A

Analysis	Calibration	NPDES ¹		RCRA (SW846) ²	
		Method	Requirement	Method	Requirement
Semivolatiles	Initial	625	Minimum of 3 levels, lowest near but above MDL. If % RSD \leq 35%, use avg RF. Otherwise calibration curve employed.	8270C	Minimum of 5 levels, % RSD for RF for CCCs ⁽⁴⁾ < 30% SPCCs ⁽⁵⁾ . RF > 0.050
	Continuing	625	One level every 24 ours. Acceptance criteria are found in the method and SOP.	8270C	Mid-level standard every 12 hours (after tuning) %D for CCCs ⁽⁴⁾ < 20 % between RF from standard and avg RF from initial SPCCs ⁽⁵⁾ : RF > 0.050.
	Ending	625	N/A	8270C	N/A
	Other	625	DFTPP ⁽⁷⁾ tuning every 24 hours before standard or sample runs.	8270C	DFTPP ⁽⁷⁾ tuning at the beginning of every 12 hour shift.

Analysis	Calibration	NPDES ¹		RCRA (SW846) ²	
		Method	Requirement	Method	Requirement
Volatiles	Initial	624	Minimum of 3 levels, lowest near but above MDL. If % RSD \leq 35%, use avg RF. Otherwise, calibration curve employed.	8260B	Minimum of 5 levels, %RSD for RF for CCCs ⁴ < 30.0% SPCCs ⁵ : RF \geq 0.300 for Chlorobenzene and 1,1,2,2-tetrachloroethane, Chloromethane and 1,1-dichloroethane, and RF > 0.100 for Bromoform
	Continuing	624	1 level every 24 hours Acceptance criteria are found in the method and SOP	8260B	Mid-level standard every 12 hours (after tuning) %Drift for CCCs ⁽⁴⁾ < 20.0% between RF from standard and avg RF from initial SPCCs ⁽⁵⁾ : RF \geq 0.300 for Chlorobenzene and 1,1,2,2-tetrachloroethane, Chloromethane and 1,1-dichloroethane, and RF > 0.100 for Bromoform
	Ending	624	N/A	8260B	N/A
	Other	624	BFB ⁽⁶⁾ tuning at the beginning of every 24 hour shift.	8260B	BFB ⁽⁶⁾ tuning at the beginning of every 12 hour shift.

Footnotes:

- ¹ National Pollutant Discharge Elimination System.
- ² Resource Conservation and Recovery Act, Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, (SW-846), Third Edition, September 1986. Contains Final Update I (July 1992), Final Update IIA (August 1993), Final Update II (September 1994), Final Update IIB (January 1995), and Final Update III (December 1996).
- ³ TCDD - 2,3,7,8-Tetrachlorodibenzo-p-dioxin.
- ⁴ CCC - Continuing Calibration Compounds.
- ⁵ SPCC - System Performance Check Compound.
- ⁶ BFB – Bromofluorobenzene.
- ⁷ DFTPP – Decafluorotriphenylphosphine.
- ⁸ Footnote deleted.
- ⁹ Method not listed in 40 CFR Part 136.

SECTION 21

MEASUREMENT TRACEABILITY (NELAC 5.5.6)

21.1 OVERVIEW

Traceability of measurements must be assured using a system of documentation, calibration, and analysis of reference standards. Laboratory equipment that are peripheral to analysis and whose calibration is not necessarily documented in a test method analysis or by analysis of a reference standard must be subject to ongoing certifications of accuracy. At a minimum, these must include procedures for checking specifications of ancillary equipment: balances, thermometers, temperature, Deionized (DI) and Reverse Osmosis (RO) water systems, automatic pipettes and other volumetric measuring devices (refer to Section 20.3). With the exception of Class A Glassware (including glass microliter syringes that have a certificate of accuracy), quarterly accuracy checks are performed for all mechanical volumetric devices. Microsyringes are verified at least semi-annually or disposed of after six months of use. Wherever possible, subsidiary or peripheral equipment is checked against standard equipment or standards that are traceable to national or international standards. Class A glassware should be routinely inspected for chips, acid etching or deformity. If the Class A glassware is suspect, the accuracy of the glassware must be assessed prior to use. Actions to correct or segregate ancillary equipment that does not meet required specifications are identified in the calibration and maintenance section of SOPs and maintenance logbooks for the specific equipment.

21.2 NIST-TRACEABLE WEIGHTS AND THERMOMETERS

Reference standards of measurement must be used for calibration only and for no other purpose, unless it can be shown that their performance as reference standards would not be invalidated.

For NIST-traceable weights and thermometers, the laboratory requires that all calibrations be conducted by a calibration laboratory accredited by A2LA, NVLAP (National Voluntary Laboratory Accreditation Program), APLAC (Asia-Pacific Laboratory Accreditation Cooperation), or EA (European Cooperation for Accreditation). A certificate and scope of accreditation is kept on file at the laboratory.

An external certified service engineer services laboratory balances on an annual basis. This service is documented on each balance with a signed and dated certification sticker. Balance calibrations are checked each day of use. All mercury thermometers are calibrated annually against a traceable reference thermometer. Temperature readings of ovens, refrigerators, and incubators are checked on each day of use.

21.3 REFERENCE STANDARDS / MATERIALS

Reference standards/materials, where commercially available, are traceable to certified reference materials. Commercially prepared standard materials are purchased from vendors accredited by A2LA, NVLAP, with an accompanying Certificate of Analysis that documents the standard purity. If a standard cannot be purchased from a vendor that supplies a Certificate of Analysis, the purity of the standard is documented by analysis. (Refer to Section 9 for additional

information on purchasing). The receipt of all reference standards must be documented. Reference standards are labeled with a unique Standard Identification Number and expiration date. All documentation received with the reference standard is retained as a QC record and references the Standard Identification Number.

All reference, primary and working standards/materials, whether commercially purchased or laboratory prepared, must be checked regularly to ensure that the variability of the standard or material from the 'true' value does not exceed method requirements. The accuracy of calibration standards is checked by comparison with a standard from a second source. In cases where a second standard manufacturer is not available, a vendor-certified different lot is acceptable for use as a second source. For unique situations, where no other source or lot is available, a standard made by a different analyst would be considered a second source. The appropriate Quality Control (QC) criteria for specific standards are defined in laboratory SOPs. In most cases, the analysis of an Initial Calibration Verification (ICV) or LCS (where there is no sample preparation) is used as the second source confirmation. These checks are generally performed as an integral part of the analysis method (e.g., calibration checks, laboratory control samples).

All standards and materials must be stored and handled according to method or manufacturer's requirements in order to prevent contamination or deterioration. Refer to The Corporate Environmental Health & Safety Manual (CW-E-M-001) or laboratory SOPs. For safety requirements, please refer to method SOPs and the laboratory Environmental Health and Safety Manual.

21.4 DOCUMENTATION AND LABELING OF STANDARDS, REAGENTS, AND REFERENCE MATERIALS

Reagents must be at a minimum the purity required in the test method. The date of reagent receipt and the expiration date are documented. The lots for most of the common solvents and acids are tested for acceptability prior to company wide purchase. Refer to TestAmerica's Corporate SOP CA-Q-S-001, Solvent and Acid Lot Testing and Approval.

All manufacturer or vendor-supplied Certificate of Analysis or Purity must be retained, stored appropriately, and readily available for use and inspection. These records are maintained in each group. Records must be kept of the date of receipt and date of expiration of standards, reagents and reference materials. In addition, records of preparation of laboratory standards, reagents, and reference materials must be retained, stored appropriately, and be readily available for use and inspection.

Commercial materials purchased for preparation of calibration solutions, spike solutions, etc., are usually accompanied with an assay certificate or the purity is noted on the label. If the assay purity is 96% or better, the weight provided by the vendor may be used without correction. If the assay purity is less than 96%, a correction must be made to concentrations applied to solutions prepared from the stock commercial material.

21.4.1 All standards, reagents, and reference materials must be labeled in an unambiguous manner. Standards are logged into standard or reagent logbooks, and are assigned a unique identification number. The following information is typically recorded in the Standards Logbook.

- Standard ID

- Description of Standard
- Department
- Preparer's name
- Final volume and number of vials prepared
- Solvent type and lot number
- Preparation date
- Expiration date
- Standard source type (stock or daughter)
- Standard type (spike, surrogate, other)
- Parent standard ID (if applicable)
- Parent standard analyte concentration (if applicable)
- Parent standard amount used (if applicable)
- Component analytes
- Final concentration of each analyte
- Comment box (text field)

Records are maintained in each group for standard and reference material preparation. These records show the traceability to purchased stocks or neat compounds. These records also include method of preparation, date of preparation, expiration date, and preparer's name or initials. Preparation procedures are provided in the Method SOPs.

21.4.2 All standards, reagents, and reference materials must be clearly labeled with a minimum of the following information:

- Expiration date (include prep date for reagents)
- Standard ID (from the Standards Logbook)
- Special health/safety warnings, if applicable

21.4.3 In addition, the following information may be helpful:

- Date of receipt for commercially purchased items or date of preparation for laboratory prepared items
- Date opened (for multi-use containers, if applicable)
- Description of standard (if different from manufacturer's label or if standard was prepared in the laboratory)
- Concentration (if applicable)
- Initials of analyst preparing standard or opening container

All containers of prepared reagents must include a preparation date, expiration date, and an ID number to trace back to preparation.

Procedures for preparation of reagents can be found in the Method SOPs.

Standard ID numbers must be traceable through associated logbooks, worksheets and raw data.

All reagents and standards must be stored in accordance to the following priority:

- 1) With the manufacturer's recommendations
- 2) With requirements in the specific analytical methods as specified in the laboratory SOP

SECTION 22

SAMPLING (NELAC 5.5.7)

22.1 OVERVIEW

The laboratory provides sampling services. Sampling procedures are described in SOP NC-SC-006, Sample Procurement Protocol.

22.2 SAMPLING CONTAINERS

The laboratory offers clean sampling containers for use by clients. These containers are obtained from reputable container manufacturers and meet EPA specifications as required. Any certificates of cleanliness that are provided by the supplier are available from the vendor electronically, or stored at the laboratory.

22.2.1 Preservatives

Upon request, preservatives are provided to the client in pre-cleaned sampling containers. In some cases containers may be purchased pre-preserved from the container supplier. Whether prepared by the laboratory or bought pre-preserved, the grades of the preservatives are at a minimum:

- Hydrochloric Acid – Reagent ACS (Certified VOA Free) or equivalent
- Methanol – Purge and Trap grade
- Nitric Acid – Instra-Analyzed or equivalent
- Sodium Bisulfate – ACS Grade or equivalent
- Sodium Hydroxide – Instra-Analyzed or equivalent
- Sulfuric Acid – Instra-Analyzed or equivalent
- Sodium Thiosulfate – ACS Grade or equivalent

22.3 DEFINITION OF HOLDING TIME

The date and time of sampling documented on the Chain-of-Custody (COC) form establishes the day and time zero. As a general rule, when the maximum allowable holding time is expressed in “days” (e.g., 14 days, 28 days), the holding time is based on calendar day measured. Holding times expressed in “hours” (e.g., 6 hours, 24 hours, etc.) are measured from date and time zero. The first day of holding time ends 24 hours after sampling. Holding times for analysis include any necessary re-analysis. However, there are some programs that determine holding time compliance based on the date and specific time of analysis compared to the time of sampling regardless of holding time length.

22.4 SAMPLING CONTAINERS, PRESERVATION REQUIREMENTS, HOLDING TIMES

The preservation and holding time criteria specified in the following tables are derived from the source documents for the methods. If method-required holding times (refer to Tables 23-1 to 23-7 and in SOPs) or preservation requirements are not met, the reports must be qualified using a flag, footnote, or case narrative. As soon as possible, or "ASAP", is an EPA designation for tests for which rapid analysis is advised; but for which neither EPA nor the laboratory have a basis for a holding time.

22.5 SAMPLE ALIQUOTS / SUBSAMPLING

Taking a representative sub-sample from a container is necessary to ensure that the analytical results are representative of the sample collected in the field. The size of the sample container, the quantity of sample fitted within the container, and the homogeneity of the sample needs consideration when sub-sampling for sample preparation. It is the laboratory's responsibility to take a representative sub-sample or aliquot of the sample provided for analysis. In that regard the following guidelines apply to analysts:

Analysts should handle each sample as if it is potentially dangerous. At a minimum, safety glasses, gloves, and lab coats must be worn when preparing aliquots for analysis.

Guidelines on taking sample aliquots and sub-sampling are located in each analytical SOP.

Tables 23-1 to 23-7 detail holding times, preservation and container requirements, and sample volumes for SDWA and NPDES methods. The sample volumes are intended to be a minimal amount to perform the method. The containers used may be of larger size.

Please note: The holding times are program specific and different programs may have different holding times for equivalent methods, e.g., there are differences in holding times for many organic analytes between SDWA and NPDES. RCRA methods may also be different.

Table 22-1. Inorganic Sample Containers, Preservatives, and Holding Times

Analytical Parameters	Matrix	Minimum Sample Size ¹	NPDES ^{2, 3, 7}		RCRA (SW846) ^{3, 4}	
			Method	Requirements	Method	Requirements
Acidity	Water	100 mL	305.1 SM2310B	250 mL plastic or glass. Cool to 4°C, 14 days	---	N/A
Alkalinity, Bicarbonate, Carbonate	Water	100 mL	310.1 2320B	250 mL plastic or glass. Cool to 4°C, 14 days	---	N/A
	Solid	N/A	---	N/A	---	N/A
	Waste	N/A	---	N/A	---	N/A
Ammonia	Water	100 mL	350.1 350.2 SM4500NH ₃ -E SM4500NH ₃ -F	500 mL plastic or glass. Cool to 4°C, 28 days	---	N/A
	Solid	N/A	---	N/A	---	N/A
	Waste	N/A	---	N/A	---	N/A
Arsenic (ASV) Anodic Stripping Voltammetry	Water	100 mL	---	N/A	7063	250 mL plastic. Cool to 4°C. HCl to pH < 2, 28 days
Biochemical Oxygen Demand (BOD), Carbonaceous	Water	1000 mL	405.1 5210B	1000 mL plastic or glass. Cool to 4°C, 48 hours	---	N/A
	Solid	N/A	---	N/A	---	N/A
	Waste	N/A	---	N/A	---	N/A
Bromide	Water	50 mL	300.0A ⁷	250 mL plastic or glass. No preservative required, 28 days	9056A	Cool to 4°C. Analyze ASAP after collection
	Solid	N/A	---	N/A	---	N/A
	Waste	N/A	---	N/A	---	N/A
Cation Exchange	Solid	8 oz	---	N/A	9081	8 or 16 oz glass. Cool to 4°C, 6 months
Chemical Oxygen Demand (COD)	Water	100 mL	410.4 5220D	250 mL glass or plastic. Cool to 4°C, H ₂ SO ₄ to pH < 2, 28 days	---	N/A
	Solid	N/A	---	N/A	---	N/A
	Waste	N/A	---	N/A	---	N/A

Analytical Parameters	Matrix	Minimum Sample Size ¹	NPDES ^{2, 3, 7}		RCRA (SW846) ^{3, 4}	
			Method	Requirements	Method	Requirements
Chloride	Water	50 mL	300.0A ⁷ 325.2	250 mL plastic or glass. No preservative required, 28 days	9056A 9251	Method 9056: Cool to 4°C. Analyze ASAP after collection. Method 9251: 250ml plastic or glass, no preservative required, 28 days
	Solid	N/A	---	N/A	---	N/A
	Waste	N/A	---	N/A	---	N/A
Chlorine, Residual	Water	100 mL	330.5	250 mL glass or plastic. Cool to 4°C, analyze immediately	---	N/A
	Solid	N/A	---	N/A	---	N/A
	Waste	N/A	---	N/A	---	N/A
Chromium (Cr ⁺⁶)	Water	100 mL	3500 Cr-D	Method 218.4: 200 mL plastic or glass. Cool to 4°C, 24 hours. Method 3500 Cr-D: 200 mL quartz, TFE, or polypropylene HNO ₃ to pH <2. Cool to 4°C. Analyze ASAP after collection	7196A	200 mL plastic or glass. Cool to 4°C, 24 hours
	Solid	20 g	---	N/A	7196A 3060A	250 mL plastic or glass, 30 days to digestion, 96 hours after digestion
	Waste	N/A	---	N/A	---	N/A
Conductivity	Water	100 mL	120.1 2510B	200 mL glass or plastic. Cool to 4°C, 28 days	9050A	200 mL glass or plastic. Cool to 4°C, 24 hours
	Solid	N/A	---	N/A	---	N/A
	Waste	N/A	---	N/A	---	N/A

Analytical Parameters	Matrix	Minimum Sample Size ¹	NPDES ^{2, 3, 7}		RCRA (SW846) ^{3, 4}	
			Method	Requirements	Method	Requirements
Cyanide (Amenable)	Water	250 mL	335.1 SM4500CN-G	1 liter plastic or glass, NaOH to pH >12 0.6g ascorbic acid ⁶ . Cool to 4°C, 14 days unless sulfide is present. Then maximum holding time is 24 hours.	9012A	1 liter plastic or glass, NaOH to pH >12 0.6g ascorbic acid ⁶ . Cool to 4°C, 14 days
	Solid	50g	---	N/A	9012A	Not Specified
	Waste	50g	---	N/A	9012A	Not Specified
Cyanide (Total)	Water	1L	335.2 335.3 335.4 ⁽⁷⁾ SM4500CN-E 335.2-CLP-M	1 liter plastic or glass, NaOH to pH >12 0.6g ascorbic acid ⁶ . Cool to 4°C, 14 days unless sulfide is present. Then maximum holding time is 24 hours.	9012A	1 liter plastic or glass, NaOH to pH >12 0.6g ascorbic acid ⁶ . Cool to 4°C, 14 days.
	Solid	50g	--	N/A	9012A	8 or 16 oz glass Teflon-lined lids, Cool to 4°C, 14 days
	Waste	50g	--	N/A	9012A	8 or 16 oz glass Teflon-lined lids, Cool to 4°C
Flashpoint (Ignitability)	Liquid	100 mL	---	N/A	1010 ASTM D93-9	No requirements, 250 mL amber glass. Cool to 4°C recommended
	Solid	100 g	--	N/A	---	N/A
	Waste	100 mL	--	N/A	---	N/A
Fluoride	Water	300 mL	300.0 ⁷ 340.2	500 mL plastic. No preservation required, 28 days.	9056A	Cool to 4°C. Analyze ASAP after collection.
	Solid	N/A	---	N/A	---	N/A
	Waste	N/A	---	N/A	---	N/A

Analytical Parameters	Matrix	Minimum Sample Size ¹	NPDES ^{2, 3, 7}		RCRA (SW846) ^{3, 4}	
			Method	Requirements	Method	Requirements
Hardness (Total)	Water	50 mL	130.2 2340B	250 mL glass or plastic, HNO ₃ to pH < 2, 6 months	---	N/A
	Solid	N/A	---	N/A	---	N/A
	Waste	N/A	---	N/A	---	N/A
Iron (Ferrous)	Water	100 mL	3500-Fe D	1 liter glass or polyethylene container, 6 months. This test should be performed in the field.	-	N/A
	Solid	N/A	-	N/A	-	N/A
	Waste	N/A	-	N/A	-	N/A
Nitrate	Water	50 mL	300.0A ⁷ SM4500NO ₃ -E	Method 300.0: 250 mL plastic or glass. Cool to 4°C, 48 hours.	9056A	Method 9056: Cool to 4°C. Analyze ASAP after collection
	Solid	N/A	---	N/A	---	N/A
	Waste	N/A	---	N/A	---	Not Specified
Nitrite	Water	50 mL	300.0A ⁷ 354.1	250 mL plastic or glass. Cool, 4°C, 48 hours	9056A	Cool, 4°C. Analyze ASAP after collection
	Solid	N/A	---	N/A	---	N/A
	Waste	N/A	---	N/A	---	N/A
Nitrate-Nitrite	Water	50 mL	353.2	250 mL plastic or glass, H ₂ SO ₄ to pH < 2, 28 days	---	N/A
	Solid	N/A	---	N/A	---	N/A
	Waste	N/A	---	N/A	---	N/A
Ortho-phosphate	Water	50 mL	300.0A ⁷ 365.1 SM4500P-E	100 mL plastic or glass. Filter on site. Cool to 4°C, 48 hours	9056A	Cool to 4°C. Analyze ASAP collection
	Solid	N/A	---	N/A	---	N/A
	Waste	N/A	---	N/A	---	N/A

Analytical Parameters	Matrix	Minimum Sample Size ¹	NPDES ^{2, 3, 7}		RCRA (SW846) ^{3, 4}	
			Method	Requirements	Method	Requirements
pH	Water	50 mL	150.1 SM4500H-B	100 mL plastic or glass. Analyze immediately. This test should be performed in the field.	9040B	100 mL plastic or glass. Analyze immediately. This test should be performed in the field. ⁽⁸⁾
	Solid	N/A	---	N/A	9045C	4 oz glass or plastic. Cool to 4°C. Analyze as soon as possible. ⁸
	Waste	N/A	---	N/A	9045C	4 oz glass or plastic, Cool to 4°C. Analyze as soon as possible. ⁸
Phenolics	Water	100 mL	420.1	500 mL glass, Cool to 4°C, H ₂ SO ₄ to pH < 2, 28 days	9065	1 liter glass recommended, Cool to 4°C, H ₂ SO ₄ to pH < 4, 28 days
	Solid	N/A	---	N/A	---	N/A
	Waste	N/A	---	N/A	9065	Not Specified
Phosphate	Water	50 mL	---	N/A	9056A	Cool to 4°C, analyze ASAP collection
	Solid	N/A	---	N/A	9056A	N/A
	Waste	N/A	---	N/A	9056A	N/A

Analytical Parameters	Matrix	Minimum Sample Size ¹	NPDES ^{2, 3, 7}		RCRA (SW846) ^{3, 4}	
			Method	Requirements	Method	Requirements
Phosphorus (Total)	Water	100 mL	365.2 365.1 SM4500P-E	100 mL plastic or glass, H ₂ SO ₄ to pH < 2, 28 days	---	N/A
	Solid	N/A	---	N/A	---	N/A
	Waste	N/A	---	N/A	---	N/A
Settleable Solids	Water	1000 mL	160.5	1000 mL plastic or glass. Cool to 4°C, 48 hours	---	N/A
	Solid	N/A	---	N/A	---	N/A
	Waste	N/A	---	N/A	---	N/A
Specific Conductance	Water	50 mL	120.1 2510B	250 mL plastic or glass. Cool to 4°C, 24 hours	9050A	250 mL plastic or glass. Cool to 4°C, 28 days
	Solid	N/A	---	N/A	---	N/A
	Waste	N/A	---	N/A	---	N/A
Sulfate (SO ₄)	Water	50 mL	300.0A ⁷ 375.4	100 mL plastic or glass. Cool to 4°C, 28 days	9056A 9038	Method 9056: Cool to 4°C. Analyze ASAP collection. Method 9038: 200 mL plastic or glass, Cool to 4°C, 28 days
	Solid	N/A	---	N/A	---	N/A
	Waste	100 mL	---	N/A	9038	200 mL plastic or glass. Cool to 4°C, 28 days

Analytical Parameters	Matrix	Minimum Sample Size ¹	NPDES ^{2, 3, 7}		RCRA (SW846) ^{3, 4}	
			Method	Requirements	Method	Requirements
Sulfide	Water	250 mL	376.1	500 mL plastic or glass. Cool to 4°C, Add 2 mL zinc acetate plus NaOH to pH > 9, 7 days	9030A 9030B/ 9034	500 mL plastic, No headspace. Cool to 4°C. Add 4 drops of 2N zinc acetate per 100 mL of sample, adjust the pH to > 9 with 6 N NaOH solution, 7 days
	Solid	50 g	---	N/A	9030A 9030B/ 9034	Cool to 4°C. Fill surface of solid with 2N Zinc acetate until moistened. Store headspace-free
	Waste	50 g	---	N/A	9030A 9030B/ 9034	Cool to 4°C. Fill surface of solid with 2N Zinc acetate until moistened. Store headspace-free
Total Dissolved Solids (Filterable)	Water	100 mL	160.1 2540C	250 mL plastic or glass. Cool to 4°C, 7 days	---	N/A
	Solid	N/A	---	N/A	---	N/A
	Waste	N/A	---	N/A	---	N/A

Analytical Parameters	Matrix	Minimum Sample Size ¹	NPDES ^{2, 3, 7}		RCRA (SW846) ^{3, 4}	
			Method	Requirements	Method	Requirements
Total Kjeldahl Nitrogen (TKN)	Water	100 mL	351.3	500 mL plastic or glass. Cool to 4°C, H ₂ SO ₄ to pH < 2, 28 days	---	N/A
	Solid	N/A	---	N/A	---	N/A
	Waste	N/A	---	N/A	---	N/A
Total Organic Carbon (TOC)	Water	100 mL	415.1 SM5310D	100 mL plastic or glass. Cool to 4°C, H ₂ SO ₄ to pH < 2, 28 days	9060 Walkley-Black	100 mL glass or 40 mL VOA vials, Cool to 4°C, H ₂ SO ₄ or HCl to pH < 2, 28 days
	Solid	N/A	---	N/A	9060 Walkley-Black	Not Specified
	Waste	N/A	---	N/A	9060 Walkley-Black	Not Specified
Total Organic Halides (TOX) (EOX)	Water	100 mL	450.1 ⁽⁷⁾	500 mL amber glass, Teflon®-lined lid. Cool to 4°C, HNO ₃ to pH < 2, no headspace, 28 days	9020B 9023 (EOX)	500 mL amber glass, Teflon®-lined lid. Cool to 4°C, H ₂ SO ₄ to pH < 2, no headspace, 28 days
	Solid	N/A	---	N/A	---	N/A
	Waste	N/A	---	N/A	---	N/A
Total Solids	Water	100 mL	160.3	250 mL plastic or glass. Cool to 4°C, 7 days	---	N/A
	Solid	N/A	---	N/A	---	N/A
	Waste	N/A	---	N/A	---	N/A
Total Suspended Solids (Nonfilterable)	Water	100 mL	160.2	250 mL plastic or glass. Cool, 4°C, 7 days	---	N/A
	Solid	N/A	---	N/A	---	N/A
	Waste	N/A	---	N/A	---	N/A

Analytical Parameters	Matrix	Minimum Sample Size ¹	NPDES ^{2, 3, 7}		RCRA (SW846) ^{3, 4}	
			Method	Requirements	Method	Requirements
Turbidity	Water	50 mL	180.1	250 mL plastic or glass. Cool, 4°C, 48 hours	---	N/A
	Solid	N/A	---	N/A	---	N/A
	Waste	N/A	---	N/A	---	N/A
Volatile Solids	Water	100 mL	160.4	250 mL plastic or glass. Cool, 4°C, 7 days	---	N/A
	Solid	N/A	---	N/A	---	N/A
	Waste	N/A	---	N/A	---	N/A
Metals (excludes Hg)	Water	100 mL	200 series	1 liter glass or polyethylene container, HNO ₃ to pH < 2, 6 months	6010B 6020	1 liter glass or polyethylene container, HNO ₃ to pH < 2, 6 months
	Solid	200 g	200 series	2, 8, or 16 oz glass or polyethylene container storage at 4 °C	6010B 6020	8 or 16 oz glass or polyethylene container, storage at 4°C, 6 months
	Waste	200 g	200 series	N/A	6010B 6020	8 or 16 oz glass or polyethylene container, storage at 4°C, 6 months
Mercury (CVAA) (CVAFS)	Water	100 mL	245.1 1631E	250 mL glass or polyethylene container, HNO ₃ to pH ≤ 2, 28 days	7470A	1 liter glass or polyethylene container, HNO ₃ to pH ≤ 2, 28 days
	Solid	200 g	--	2, 8, or 16 oz glass or polyethylene container. Cool to 4°C, 28 days. Not applicable for Method 1631E.	7471A	8 or 16 oz glass or polyethylene container. Cool to 4°C, 28 days (CORP-MT-0007)
	Waste	200 g	--	N/A	7471A	8 or 16 oz glass or polyethylene container. Cool, 4°C, 28 days (CORP-MT-0007)

Footnotes

- ¹ Minimum sample size indicates sample amount needed for a single analysis. Matrix spikes or duplicates will require an additional sample amount of at least this amount for each additional QC sample aliquot required.
- ² National Pollutant Discharge Elimination System - MCAWW, March 1983.
- ³ Holding times are calculated from date of collection. Holding Times are determined based on date of collection to preparation/analysis.
- ⁴ Resource Conservation and Recovery Act, Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, (SW-846), Third Edition, September 1986. Contains Final Update I (July 1992), Final Update IIA, (August 1993), Final Update II (September 1994), Final Update IIB (January 1995), and Final Update III (December 1996).
- ⁵ Solid matrix type includes soil, sediment, sludge and other solid materials not classified as waste.
- ⁶ Samples to be analyzed for cyanide should be field-tested for residual chlorine. If residual chlorine is detected, ascorbic acid should be added.
- ⁷ Method not listed in 40 CFR Part 136.
- ⁸ If not done in the field (ASAP) per the method and requested by client, analyze in lab within 48 hours.
- ⁹ EPA issued memo recommending not to use reactive cyanide and sulfide methods.

Table 22-2. Organic Sample Containers, Preservatives, and Holding Times

Analytical Parameters	Matrix	Minimum Sample Size ¹	NPDES ^{2, 3}		RCRA (SW846) ^{3, 4}	
			Method	Requirements	Method ⁶	Requirements
Aromatic Volatiles	Water	40 mL	602	40 mL glass, VOA vial (in triplicate) with Teflon®-lined septa without headspace. Cool to 4°C, 7 days with pH > 2, 14 days with pH ≤ 2	8021B	40 mL glass, VOA vial (in triplicate) with Teflon®-lined septa without headspace. Cool to 4°C, 1:1 HCl to pH <2, 14 days with pH ≤ 2
	Solid ⁵	5 g or 25 g	--	N/A	8021B	4 or 8 oz glass with Teflon®-lined lid. Cool to 4 °C, 14 days. Field preserved with methanol for medium level analysis. Soil sample can also be taken by using the EnCore™ sampler and preserved in the lab within 48 hours of sampling. Maximum holding time for Encore Sampler is 48 hours (before the sample is added to methanol). Cool, 4°C ¹²
	Waste	5 g or 25 g	--	N/A	8021B	4 or 8 oz glass with Teflon®-lined lid. Cool to 4 °C, 14 days. Field preserved with methanol for medium level analysis. Soil sample can also be taken by using the EnCore™ sampler and preserved in the lab within 48 hrs of sampling. Max holding time for EnCore™ sampler is 48 hrs (before the sample is added to methanol). Cool to 4°C ¹²

Analytical Parameters	Matrix	Minimum Sample Size ¹	NPDES ^{2, 3}		RCRA (SW846) ^{3, 4}	
			Method	Requirements	Method ⁶	Requirements
Halogenated Volatiles by GC	Water	40 mL	--	N/A	8021B	40 mL glass, VOA vial (in triplicate) with Teflon®-lined septa without headspace. Cool to 4°C, 1:1 HCl to pH ≤ 2, 14 days
	Solid ⁵	5 g or 25 g	--		8021B	4 or 8 oz glass with Teflon®-lined lid. Cool to 4 °C, 14 days. Field preserved with methanol for medium level analysis. Soil sample can also be taken by using the EnCore™ sampler and preserved in the lab within 48 hours of sampling. Maximum holding time for Encore Sampler is 48 hours (before the sample is added to methanol). Cool to 4°C ¹²
	Waste	5 g or 25 g	--	N/A	8021B	4 or 8 oz glass with Teflon®-lined lid. Cool to 4 °C, 14 days. Field preserved with methanol for medium level analysis. Soil sample can also be taken by using the EnCore™ sampler and preserved in the lab within 48 hours of sampling. Maximum holding time for Encore Sampler is 48 hours (before the sample is added to methanol). Cool, 4°C ¹² .

Analytical Parameters	Matrix	Minimum Sample Size ¹	NPDES ^{2,3}		RCRA (SW846) ^{3,4}	
			Method	Requirements	Method ⁶	Requirements
Herbicides	Water	1L	615 ⁽¹⁰⁾	1 liter amber glass with Teflon®-lined lid, Sodium thiosulfate or ascorbic acid if residual chlorine present. Cool to 4°C, Extraction, 7 days. Analysis, 40 days after extraction	8151A	1 liter amber glass with Teflon®-lined lid. If residual chlorine present, add 3 mL sodium thiosulfate per gallon. Cool to 4°C. Extraction, 7 days. Analysis, 40 days of the start of extraction.
	Solid	50 g	--	N/A	8151A	4 or 8 oz glass widemouth with Teflon®-lined lid. Cool to 4 °C. Extraction, 14 days. Analysis, 40 days of the start of the extraction.
	Waste	50 g	--	N/A	8151A	4 or 8 oz glass widemouth with Teflon®-lined lid. Cool to 4 °C. Extraction, 14 days. Analysis, 40 days of the start of the extraction.

Analytical Parameters	Matrix	Minimum Sample Size ¹	NPDES ^{2, 3}		RCRA (SW846) ^{3, 4}	
			Method	Requirements	Method ⁶	Requirements
Pesticides/ PCBs	Water	1L	608	1 liter amber glass with Teflon®-lined lid, Adjust pH to 5-9 if extraction not to be done within 72 hours of sampling. Add sodium thiosulfate if residual chlorine present and aldrin is being determined. Cool, 4°C. Extraction, 7 days. Analysis, 40 days after extraction.	8081A 8082	1 liter amber glass with Teflon®-lined lid, If residual chlorine present, add 3 mL 10% sodium thiosulfate per gallon. Cool, 4°C. Extraction, 7 days. Analysis, 40 days of the start of the extraction.
	Solid	50 g	---	N/A	8081A 8082	4 or 8 oz glass wide mouth with Teflon®-lined lid. Cool, 4°C. Extraction, 14 days. Analysis, 40 days of the start of the extraction.
	Waste	50 g	---	N/A	8081A 8082	4 or 8 oz glass wide mouth with Teflon®-lined lid. Cool, 4°C. Extraction, 14 days. Analysis, 40 days of the start of the extraction.

Analytical Parameters	Matrix	Minimum Sample Size ¹	NPDES ^{2, 3}		RCRA (SW846) ^{3, 4}	
			Method	Requirements	Method ⁶	Requirements
Petroleum Hydrocarbons /Oil and Grease	Water	1 L	1664A ⁽⁷⁾	1 liter glass, Cool, 4°C HCl or H ₂ SO ₄ to pH <2 28 days	9071B	1 liter glass, Cool, 0-4°C HCl or H ₂ SO ₄ to pH <2 28 days
	Solid	30 g	1664A ⁽⁷⁾	8 or 16 oz. Wide mouth glass jar, Cool, 4°C, 28 days	9071B	8 or 16 oz. wide mouth glass jar, Cool, 0-4°C, 28 days
	Waste	---	---	N/A	9071B	N/A
Purgeable Halocarbons by GC	Water	40 mL	601	40 mL glass VOA vial (in triplicate) with Teflon®-lined septa with no headspace, Cool, 4°C, 14 days.	8021B	40 mL glass VOA vial (in triplicate) with Teflon®-lined septa with no headspace, Cool, 4°C, 1:1 HCl to pH ≤ 2, 14 days.
	Solid	5 g or 25 g	---	N/A	8021B	4 or 8 oz glass with Teflon®-lined lid, Cool 4 °C, 14 days. Field preserved with methanol for medium level analysis. Soil sample can also be taken by using the EnCore™ sampler and preserved in the lab within 48 hours of sampling. Maximum holding time for EnCore™ sampler is 48 hrs (before the sample is added to methanol). Cool, 4°C ¹² .

Analytical Parameters	Matrix	Minimum Sample Size ¹	NPDES ^{2, 3}		RCRA (SW846) ^{3, 4}	
			Method	Requirements	Method ⁶	Requirements
Purgeable Halocarbons by GC (cont'd)	Waste	5 g or 25 g	---	N/A	8021B	4 or 8 oz glass with Teflon®-lined lid, Cool 4 °C, 14 days. Field preserved with methanol for medium level analysis. Soil sample can also be taken by using the EnCore™ sampler and preserved in the lab within 48 hours of sampling. Maximum holding time for EnCore™ sampler is 48 hours (before the sample is added to methanol). Cool, 4°C ¹²
Semivolatiles	Water	1L	625	1 liter amber glass with Teflon®-lined lid. Cool, 4°C. Extraction, 7 days. Analysis, 40 days.	8270C	1 liter amber glass with Teflon®-lined lid, If residual chlorine present, add 3 mL sodium thiosulfate per gallon. Cool, 4°C. Extraction, 7 days. Analysis, within 40 days of extraction.
	Solid	50 g	---	N/A	8270C	8 or 16 oz glass wide mouth with Teflon-lined lid. Cool, 4°C. Extraction, 14 days. Analysis, within 40 days of extraction.
	Waste	50 g	---	N/A	8270C	8 or 16 oz glass wide mouth with Teflon®-lined lid. Cool, 4°C. Extraction, 14 days. Analysis, within 40 days of extraction.

Analytical Parameters	Matrix	Minimum Sample Size ¹	NPDES ^{2,3}		RCRA (SW846) ^{3,4}	
			Method	Requirements	Method ⁶	Requirements
Volatile Organics	Water	40 mL	624	40 mL glass, VOA vial (in triplicate) with Teflon®-lined septa without headspace. Cool to 4°C. Add sodium thiosulfate if residual chlorine, 7 days with pH > 2, 14 days with pH ≤ 2 ⁸ .	8260B	40 mL glass, VOA vial (in triplicate) with Teflon®-lined septa without headspace. Cool to 4°C. Add sodium thiosulfate if residual chlorine, 1:1 HCl to pH ≤ 2, 14 days with pH ≤ 2 ⁹ .
	Solid ⁵	5 g or 25 g	--	N/A	8260B	4 or 8 oz glass with Teflon®-lined lid. Cool to 4 °C, 14 days. Field preserved with sodium bisulfate solution for low level analysis, or with methanol for medium level analysis. Soil sample can also be taken by using the EnCore™ sampler and preserved in the lab within 48 hrs of sampling. Maximum holding time for EnCore™ sampler is 48 hrs (before the sample is added to methanol or sodium bisulfate). Cool to 4°C ⁽¹²⁾
	Waste	5 g or 25 g	--	N/A	8260B	4 or 8 oz glass with Teflon®-lined lid, Cool 4 °C, 14 days. Field preserved with sodium bisulfate solution for low level analysis, or with methanol for medium level analysis. Soil sample can also be taken by using the EnCore™ sampler and preserved in the lab within 48 hrs of sampling. Maximum holding time for EnCore™ sampler is 48 hrs (before sample is added to methanol or sodium bisulfate). Cool to 4°C ¹²

Footnotes

- ¹ Minimum sample size indicates sample amount needed for a single analysis. Matrix spikes or duplicates will require an additional sample amount of at least this amount for each additional QC sample aliquot required.
- ² National Pollutant Discharge Elimination System - 40 CFR Part 136, Appendix A.
- ³ Holding times are calculated from the date of collection.
- ⁴ Resource Conservation and Recovery Act, Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, Third Edition, September 1986. Contains Final Update I (July 1992), Final Update IIA (August 1993), Final Update II (September 1994), Final Update IIB (January 1995), and Final Update III (December 1996).
- ⁵ Solid matrix type includes soil, sediment, sludge or other solids not classified as waste.
- ⁶ Only one determination method is listed when separate methods are required for preparation and analysis.
- ⁷ Method 1664 was promulgated by the EPA with an effective date of June 14, 1999.
- ⁸ For acrolein and acrylonitrile the pH should be adjusted to 4-5. This pH adjustment is not required if acrolein is not measured. Samples requiring analysis of acrolein that received no pH adjustment must be analyzed within three days of sampling.
- ⁹ For acrolein and acrylonitrile the pH should be adjusted to 4-5.
- ¹⁰ Method not listed in 40 CFR Part 136.
- ¹¹ Should only be used in the presence of residual chlorine.
- ¹² Depending on regulatory programs, EnCore™ samplers may be preserved for up to 14 days from sampling by freezing at -5 to -12°C until analysis. Alternatively the EnCore™ sample may be transferred to a 40-ml VOA vial and preserved by freezing at -5 to -12°C until analysis. Some regulatory agencies may require 4 or 8 oz glass with Teflon®-lined lid, Cool 4°C, 14 days. This technique is not recommended, but will be supported where required. (Preservation and holding times are subject to client specifications.)

Table 22-3. Sample Containers, Preservatives, and Holding Times for TCLP¹ and SPLP²

Analytical Parameters	Matrix	Minimum Sample Size	TCLP Method 1311 and SPLP Method 1312 Requirements	
			From Field Collection to TCLP/SPLP Extraction	From TCLP/SPLP Extraction to Analysis
Mercury	Liquid Solid Waste	1L	1L glass, Cool, 4°C, 28 days	Glass or polyethylene 28 days
Metals (except mercury)	Liquid Solid Waste	1L	1L glass, Cool, 4°C, 180 days	Glass or polyethylene 180 days
Semivolatiles	Liquid Solid Waste	1L	1L glass, Cool 4°C, 14 days	1L glass Extraction of leachate within 7 days of TCLP extraction, Analyze extract within 40 days
Volatiles	Liquid Solid Waste	6 oz	4 oz glass, Cool 4°C, 14 days	40 mL glass, 14 days

Footnotes

- ¹ TCLP = Toxicity Characteristic Leaching Procedure
² SPLP = Synthetic Precipitation Leaching Procedure

SECTION 23

HANDLING OF SAMPLES (NELAC 5.5.8)

Sample management procedures at the laboratory ensure that sample integrity and custody are maintained and documented from sampling/receipt through disposal.

23.1 CHAIN OF CUSTODY (COC)

The COC form is the written documented history of any sample and is initiated when bottles are sent to the field, or at the time of sampling. This form is completed by the Sampling personnel and accompanies the samples to the laboratory where it is received and stored under the laboratory's custody. The purpose of the COC form is to provide a legal written record of the handling of samples from the time of collection until they are received at the laboratory. It also serves as the primary written request for analyses from the client to the laboratory. The COC form acts as a purchase order for analytical services when no other contractual agreement is in effect. An example of a COC form may be found in Figure 23-1.

23.1.1 Field Documentation

The information the sampler needs to provide at the time of sampling on the container label is:

- Sample identification
- Date and time
- Preservative

During the sampling process, the COC form is completed and must be legible (see Figure 23-1). This form includes information such as:

- Client name, address, phone number and fax number (if available)
- Project name and/or number
- The sample identification
- Date, time and location of sampling
- Sample collectors name
- The matrix description
- The container description
- The total number of each type of container
- Preservatives used
- Analysis requested
- Requested turnaround time (TAT)
- Any special instructions
- Purchase Order number or billing information (e.g. quote number) if available
- The date and time that each person received or relinquished the sample(s), including their signed name.

The samples are stored in a cooler with ice, as applicable, and remain solely in the possession of the client's field technician until the samples are delivered to the laboratory. The sample collector must assure each container is in his/her physical possession or in his/her view at all times, or stored in such a place and manner to preclude tampering. The field technician relinquishes the samples in writing on the COC form to the Sample Control personnel at the laboratory or to a TestAmerica courier. Samples are only considered to be received by lab when personnel at the laboratory have physical contact with the samples.

Note: Independent couriers are not required to sign the COC form. The COC is usually kept in the sealed sample cooler. The COC is stored with project information and the report.

23.1.2 Legal / Evidentiary Chain-of-Custody

The lab does not accept samples that require legal Chain-of-Custody.

23.2 SAMPLE RECEIPT

Samples are received at the laboratory by designated Sample Receiving personnel, and a unique laboratory project identification number is assigned. Each sample container must be assigned a unique sample identification number that is cross-referenced to the client identification number such that traceability of test samples is unambiguous and documented. Each sample container is affixed with a durable sample identification label. Sample acceptance, receipt, tracking, and storage procedures are summarized in the following sections. SOP NC-SC-005, Sample Receiving and Sample Control, describes the laboratory's sample receipt procedure.

23.2.1 Laboratory Receipt

Samples must be received and logged in at TestAmerica by a designated sample custodian or other properly trained associate. Upon sample receipt, the sample custodian shall, as appropriate:

- Wear appropriate personal protective equipment. At a minimum, this consists of cut-resistant gloves, a lab coat, and safety glasses
- Examine the shipping containers to verify that the custody tape is intact
- Examine all sample containers for damage
- Open shipping containers in adequately ventilated areas to assure worker safety
- Determine if the temperature required by the requested testing program has been maintained during shipment. Document the shipping container temperature on the Cooler Receipt Form
- Compare samples received against those listed on the COC
- Verify that sample holding times have not been exceeded
- Examine all shipping records for accuracy and completeness
- Determine sample pH (if required for the scheduled analysis) (except VOA and TOX samples) and record on the Cooler Receipt Form (CRF)
- Sign and date the COC immediately (only after shipment is accepted) and attach the waybill
- Note any problems associated with the coolers and samples on the cooler receipt form and

notify the PM who in turn notifies the client

- Attach durable (water-resistant) laboratory sample container labels with unique laboratory identification number and test
- Place the samples in proper laboratory storage.

A Cooler Receipt Form (CRF) or an equivalent form/system is generated by sample control during the sample log-in process to document anomalies identified upon the receipt of samples in the laboratory. These anomalies are outside of laboratory control and do not require corrective actions to be taken within the laboratory. The affected client must be notified by the PM or designee of all CRFs generated for their samples. The PM is responsible for resolving with the client how to proceed with the samples and documenting the decision to proceed with the analysis of compromised samples. CRFs must be resolved prior to sample preparation and analysis. The completed CRF must be stored in the project file. An example CRF is shown in Figure 24-4. The report narrative must include an explanation of sample receiving related anomalies.

23.2.1.1 Unique Sample Identification

A unique lot number is generated for each project that is logged. The lot number is nine characters in length, and is based on the date of receipt. For example, Lot **A9C010121** is described as follows:

A - TestAmerica location where the samples were received (A = North Canton, C = Pittsburgh, etc.)

9 - Last digit of the year (i.e., 2009)

C - Month (i.e., A = January, B = February, C = March)

01 - These two numeric characters identify the day of the month--in this case, the first day of the month.

0121 - These four numeric characters are the sequential assignment of numbers specific to each lot received. Each day, the first lot logged receives the number "0101"; the second lot receives the number "0102", etc.

As each sample is logged, individual *sample numbers* are created in sequential order, noted as the three-digit suffix following the lot number. For example, four samples were received on May 10, 2008 for PCB analysis with the following client IDs: AB100, AB101, AB102, AB103.

<u>Client ID - Lot No. - Sample No.</u>	<u>Analysis</u>
AB100A8E100101-001	PCB
AB101A8E100101-002	PCB
AB102A8E100101-003	PCB
AB103A8E100101-004	PCB

If a client requests an MS/MSD for a sample(s), it is denoted in LIMS by an "S" for the MS and a "D" for the MSD.

Work Order Numbers: As each parameter is logged, a random unique 8-digit Work Order number is generated by LIMS. For example, Work Order **A5WE1-1-1C** is described as follows:

- A5WE1** - The first five characters of the Work Order number identifies each unique sample.
- 1** - The "modifier" indicates the run number. This number will always be a "1" at log-in. However, additional modifier numbers may be generated by the analytical lab groups when necessary (example: for a re-extract).
- 1C** - The "suffix" identifies a specific test for each sample, but is unique to the test being performed on each sample.

Each sample container representing the same sample (as indicated by the client ID) will have the same 5-digit Work Order number, along with a 3-digit suffix that corresponds to the bottle count (example: -001, -002, -003, etc.). For example, if five containers are submitted for the same sample and the LIMS-generated Work Order number is CREE4, LIMS will generate five labels--CREE4-001, CREE4-002, CREE4-003, CREE4-004, and CREE4-005. These numbers are used to track sample containers through the analytical process.

23.3 Sample Acceptance Policy

The laboratory has a written sample acceptance policy outlined in SOP NC-SC-005, Sample Receiving and Sample Control, that clearly outlines the circumstances under which samples must be accepted or rejected. These include:

- A COC filled out completely
- Samples must be properly labeled
- Proper sample containers with adequate volume for the analysis and necessary QC
- Samples must be preserved according to the requirements of the requested analytical method
- Sample holding times must be adhered to
- All samples submitted for water/solid Volatile Organic analyses must have a Trip Blank submitted at the same time
- The Project Manager must be notified if any sample is received in damaged condition.

Data from samples which do not meet these criteria are flagged and the nature of the variation from policy is defined. A copy of the sample acceptance policy is provided to each client prior to shipment of samples.

Once sample acceptance is verified, the samples are logged into LIMS according to SOP NC-SC-005.

23.4 SAMPLE STORAGE

In order to avoid deterioration, contamination or damage to a sample during storage and handling, from the time of receipt until all analyses are complete, samples are stored in refrigerators suitable for the sample matrix. Metals samples may be unrefrigerated. In addition, samples to be analyzed for volatile organic parameters are stored in separate refrigerators designated for volatile organic parameters only. Samples are never to be stored with reagents, standards, or materials that may create contamination.

To ensure the integrity of the samples during storage, refrigerator blanks are maintained in the volatile sample refrigerators and analyzed every week.

Access to the laboratory is controlled such that sample storage need not be locked at all times unless a project specifically demands it. Samples are accessible to laboratory personnel only. Visitors to the laboratory are prohibited from entering the refrigerator and laboratory areas unless accompanied by an employee of TestAmerica.

23.5 HAZARDOUS SAMPLES AND FOREIGN SOILS

All samples per SOP are treated as hazardous. If any extra or known hazards are present in the sample, the sample is flagged and precautions / instructions are put in the comments. Hazardous samples are segregated out, and go into the waste stream profile for the nature of the hazard. All soils--foreign and domestic--go to a USDA approved incinerator.

23.6 SAMPLE SHIPPING

In the event the laboratory needs to ship samples, the samples are placed in a cooler with enough ice to ensure the samples remain just above freezing and at or below 6.0°C during transit. The samples are carefully surrounded by packing material to avoid breakage (yet maintain appropriate temperature). A trip blank is enclosed for those samples requiring water/solid volatile organic analyses. The Chain-of-Custody form is signed by the Sample Control technician and attached to the shipping paperwork. Samples are generally shipped overnight express or hand-delivered by a TestAmerica courier to maintain sample integrity. All personnel involved with shipping and receiving samples must be trained to maintain the proper Chain-of-Custody documentation and to keep the samples intact and on ice. The Environmental, Health and Safety Manual contains additional shipping requirements.

Note: If a client does not request trip blank analysis on the COC or other paperwork, the laboratory will not analyze the trip blanks that were supplied. However, in the interest of good client service, the laboratory will advise the client at the time of sample receipt that it was noted that they did not request analysis of the trip blank; and that the laboratory is providing the notification to verify that they are not inadvertently omitting a key part of regulatory compliance testing.

23.7 SAMPLE DISPOSAL

Samples should be retained for a minimum of 30 days after the project report is sent; however, provisions may be made for earlier disposal of samples once the holding time is exceeded. Some samples are required to be held for longer periods based on regulatory or client

requirements (e.g., 60 days after project report is sent). The laboratory must follow the longer sample retention requirements where required by regulation or client agreement. Several possibilities for sample disposal exist--the sample may be consumed completely during analysis, the sample may be returned to the customer or location of sampling for disposal, or the sample may be disposed of in accordance with the laboratory's waste disposal procedures (SOP NC-SC-005, Sample Receiving and Sample Control). All procedures in the laboratory Environmental, Health and Safety Manual are followed during disposal. Samples are normally maintained in the laboratory no longer than two months from receipt unless otherwise requested. Unused portions of samples found or suspected to be hazardous according to state or federal guidelines may be returned to the client upon completion of the analytical work. Waste disposal complies with all federal and state laws and regulations.

If a sample is part of a known litigation, the affected legal authority, sample data user, and/or submitter of the sample must participate in the decision about the sample disposal. All documentation and correspondence concerning the disposal decision process must be kept on file. Pertinent information includes the date of disposal, nature of disposal (such as sample depletion, hazardous waste facility disposal, return to client), and names of individuals who conducted the arrangements and physically completed the task. Sample labels are destroyed through the disposal method, e.g., samples are incinerated. A Waste Manifest is completed.

Figure 23-1. Example: Chain of Custody (COC)

[illegible]

Figure 23-2.

Example: Custody Seal

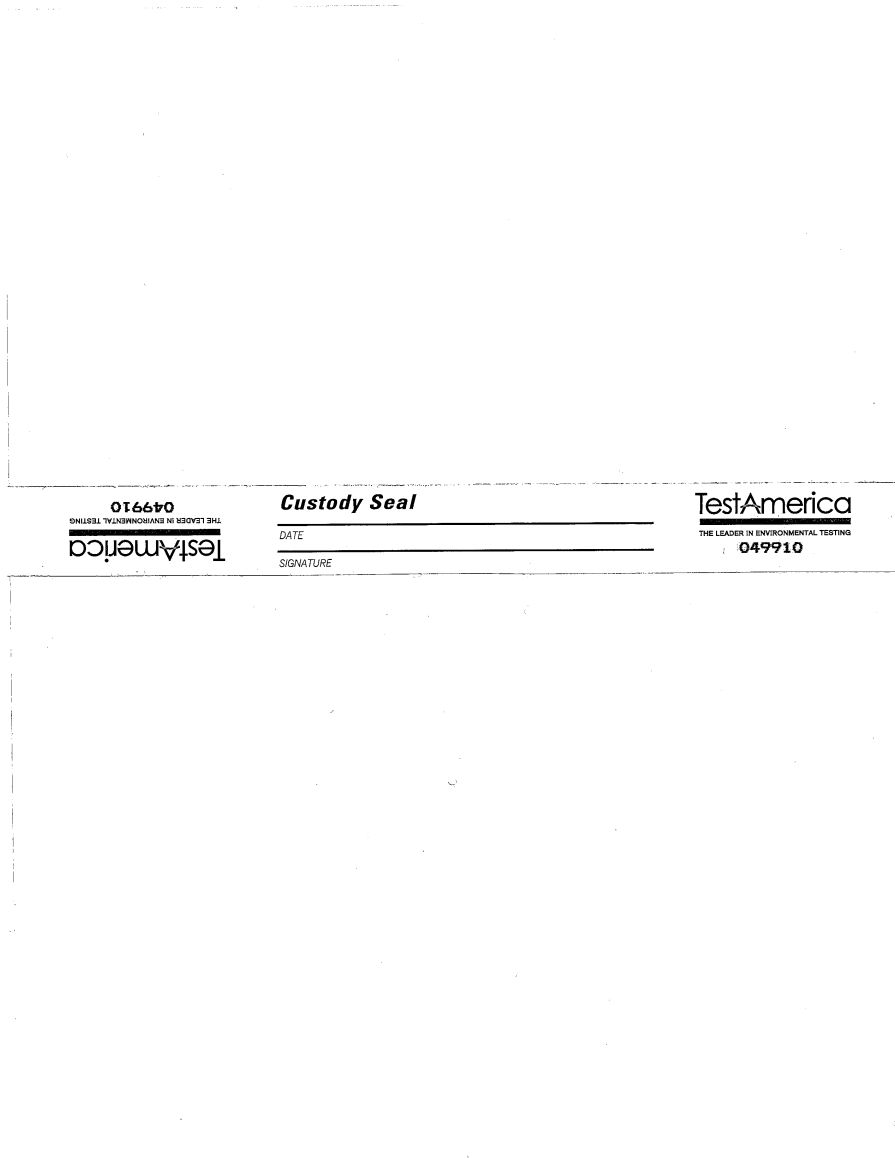


Figure 23-3. Example: Internal Chain of Custody (COC)

**TestAmerica Laboratories, Inc.
Sample Control Record**

Client:

Lot Number:

Case Number/SDG:

Storage Location:

Laboratory Sample ID	Transferred By	Date	Entered	Removed	Reason	Date Returned

Figure 23-4. Example: Cooler Receipt Form (Page 1)

TestAmerica Cooler Receipt Form/Narrative North Canton Facility		Lot Number: _____	
Client _____ Project _____ By _____			
Cooler Received on _____ Opened on _____ (Signature) _____			
FedEx <input type="checkbox"/> UPS <input type="checkbox"/> DHL <input type="checkbox"/> FAS <input type="checkbox"/> Stetson <input type="checkbox"/> Client Drop Off <input type="checkbox"/> TestAmerica Courier <input type="checkbox"/> Other _____			
TestAmerica Cooler # _____ Multiple Coolers <input type="checkbox"/> Foam Box <input type="checkbox"/> Client Cooler <input type="checkbox"/> Other _____			
1. Were custody seals on the outside of the cooler(s)? Yes <input type="checkbox"/> No <input type="checkbox"/> Intact? Yes <input type="checkbox"/> No <input type="checkbox"/> NA <input type="checkbox"/>			
If YES, Quantity _____ Quantity Unsalvageable _____			
Were custody seals on the outside of cooler(s) signed and dated? Yes <input type="checkbox"/> No <input type="checkbox"/> NA <input type="checkbox"/>			
Were custody seals on the bottle(s)? Yes <input type="checkbox"/> No <input type="checkbox"/>			
If YES, are there any exceptions? _____			
2. Shipper's packing slip attached to the cooler(s)? Yes <input type="checkbox"/> No <input type="checkbox"/>			
3. Did custody papers accompany the sample(s)? Yes <input type="checkbox"/> No <input type="checkbox"/> Relinquished by client? Yes <input type="checkbox"/> No <input type="checkbox"/>			
4. Were the custody papers in the appropriate place? Yes <input type="checkbox"/> No <input type="checkbox"/>			
5. Packing material used: Bubble Wrap <input type="checkbox"/> Foam <input type="checkbox"/> None <input type="checkbox"/> Other _____			
6. Cooler temperature upon receipt _____ °C See back of form for multiple coolers/temps <input type="checkbox"/>			
METHOD: IR <input type="checkbox"/> Other <input type="checkbox"/>			
COOLANT: Wet Ice <input type="checkbox"/> Blue Ice <input type="checkbox"/> Dry Ice <input type="checkbox"/> Water <input type="checkbox"/> None <input type="checkbox"/>			
7. Did all bottles arrive in good condition (Unbroken)? Yes <input type="checkbox"/> No <input type="checkbox"/>			
8. Could all bottle labels be reconciled with the COC? Yes <input type="checkbox"/> No <input type="checkbox"/>			
9. Were sample(s) at the correct pH upon receipt? Yes <input type="checkbox"/> No <input type="checkbox"/> NA <input type="checkbox"/>			
10. Were correct bottle(s) used for the test(s) indicated? Yes <input type="checkbox"/> No <input type="checkbox"/>			
11. Were air bubbles >6 mm in any VOA vials? Yes <input type="checkbox"/> No <input type="checkbox"/> NA <input type="checkbox"/>			
12. Sufficient quantity received to perform indicated analyses? Yes <input type="checkbox"/> No <input type="checkbox"/>			
13. Was a Trip Blank present in the cooler(s)? Yes <input type="checkbox"/> No <input type="checkbox"/> Were VOAs on the COC? Yes <input type="checkbox"/> No <input type="checkbox"/>			
Contacted PM _____ Date _____ by _____ via Verbal <input type="checkbox"/> Voice Mail <input type="checkbox"/> Other <input type="checkbox"/>			
Concerning _____			
14. CHAIN OF CUSTODY			
The following discrepancies occurred:			
15. SAMPLE CONDITION			
Sample(s) _____ were received after the recommended holding time had expired.			
Sample(s) _____ were received in a broken container.			
Sample(s) _____ were received with bubble >6 mm in diameter. (Notify PM).			
16. SAMPLE PRESERVATION			
Sample(s) _____ were further preserved in Sample _____			
Receiving to meet recommended pH level(s). Nitric Acid Lot # 100108-HNO ₃ - Sulfuric Acid Lot # 100108-H ₂ SO ₄ ; Sodium Hydroxide Lot # 073007-NaOH; Hydrochloric Acid Lot # 092006-HCl; Sodium Hydroxide and Zinc Acetate Lot # 050205-(CH ₃ COO) ₂ ZN/NaOH. What time was preservative added to sample(s)? _____			
Client ID	pH	Date	Initials

Example: Cooler Receipt Form (Page 2)

[illegible]

SECTION 24

ASSURING THE QUALITY OF TEST RESULTS (NELAC 5.5.9)

24.1 OVERVIEW

In order to assure our clients of the validity of their data, the laboratory continuously evaluates the quality of the analytical process. The analytical process is controlled not only by instrument calibration as discussed in Section 20, but also by routine process quality control measurements (e.g., Blanks, Laboratory Control Samples (LCS), Matrix Spikes (MS), duplicates (DUP), surrogates, Internal Standards (IS)). These quality control checks are performed as required by the method or regulations to assess precision and accuracy. In addition to the routine process quality control samples, Proficiency Testing (PT) Samples (concentrations unknown to laboratory) are analyzed to help ensure laboratory performance.

24.2 CONTROLS

Sample preparation or pre-treatment is commonly required before analysis. Typical preparation steps include homogenization, grinding, solvent extraction, sonication, acid digestion, distillation, reflux, evaporation, drying and ashing. During these pre-treatment steps, samples are arranged into discreet manageable groups referred to as preparation (prep) batches. Prep batches provide a means to control variability in sample treatment. Control samples are added to each prep batch to monitor method performance and are processed through the entire analytical procedure with investigative/field samples.

24.3 NEGATIVE CONTROLS

Table 24-1. Example – Negative Controls

Control Type	Details
Method Blanks (MB)	<p>are used to assess preparation and analysis for possible contamination during the preparation and processing steps.</p> <p>The specific frequency of use for method blanks during the analytical sequence is defined in the specific standard operating procedure for each analysis. Generally it is 1 for each batch of samples; not to exceed 20 environmental samples.</p> <p>The method blank is prepared from a clean matrix similar to that of the associated samples that is free from target analytes (e.g., Reagent water, Ottawa sand, glass beads, etc.) and is processed along with and under the same conditions as the associated samples.</p> <p>The method blank goes through all of the steps of the process (including as necessary: filtration, clean-ups, etc.).</p>
Calibration Blanks	<p>are prepared and analyzed along with calibration standards where applicable or injected at specified frequencies throughout an analytical sequence. They are prepared using the same reagents that are used to prepare the standards. In some analyses the calibration blank may be included in the calibration curve. These blanks may be termed Initial Calibration Blanks (ICB) or Continuing Calibration Blanks (CCB).</p>

Table 24-1. Example – Negative Controls

Control Type	Details
Instrument Blanks	are blank reagents or reagent water that may be processed during an analytical sequence in order to assess contamination in the analytical system. In general, instrument blanks are used to differentiate between contamination caused by the analytical system and that caused by the sample handling or sample prep process. Instrument blanks may also be inserted throughout the analytical sequence to minimize the effect of carryover from samples with high analyte content.
Trip Blanks ¹	are required to be submitted by the client with each shipment of samples requiring aqueous and solid volatiles analyses. Additionally, trip blanks may be prepared and analyzed for volatile analysis of air samples, when required by the client. A trip blank may be purchased (certified clean) or is prepared by the laboratory by filling a clean container with pure deionized water that has been purged to remove any volatile compounds. Appropriate preservatives are also added to the container. The trip blank is sent with the bottle order and is intended to reflect the environment that the containers are subjected to throughout shipping and handling and help identify possible sources if contamination is found. The field sampler returns the trip blank in the cooler with the field samples.
Field Blanks ¹	are sometimes used for specific projects by the field samplers. A field blank prepared in the field by filling a clean container with pure reagent water and appropriate preservative, if any, for the specific sampling activity being undertaken. (EPA OSWER)
Equipment Blanks ¹	are also sometimes created in the field for specific projects. An equipment blank is a sample of analyte-free media which has been used to rinse common sampling equipment to check effectiveness of decontamination procedures. (NELAC)
Holding Blanks	also referred to as refrigerator or freezer blanks, are used to monitor the sample storage units for volatile organic compounds during the storage of VOA samples in the laboratory

¹ When known, these field QC samples should not be selected for matrix QC as it does not provide information on the behavior of the target compounds in the field samples. Usually, the client sample ID will provide information to identify the field blanks with labels such as "FB", "EB", or "TB."

Evaluation criteria and corrective action for these controls are defined in the specific standard operating procedure for each analysis.

24.4 POSITIVE CONTROLS

Control samples (e.g., QC indicators) are analyzed with each batch of samples to evaluate data based upon:

- 1) Method Performance [Laboratory Control Sample (LCS) or Blank Spike (BS)], which entails both the preparation and measurement steps
- 2) Matrix Effects (Matrix Spike (MS) or Sample Duplicate (MD, DUP), which evaluates field sampling accuracy, precision, representativeness, interferences, and the effect of the matrix on the method performed.

Each regulatory program and each method within those programs specify the control samples that are prepared and/or analyzed with a specific batch.

Note that frequency of control samples vary with specific regulatory, methodology, and project-specific criteria. Complete details on method control samples are as listed in each analytical SOP.

24.4.1 Method Performance Control - Laboratory Control Sample (LCS)

24.4.1.1 The LCS measures the accuracy of the method in a blank matrix and assesses method performance independent of potential field sample matrix effects in a laboratory batch.

24.4.1.2 The LCS is prepared from a clean matrix similar to that of the associated samples that is free from target analytes (for example: Reagent water, Ottawa sand, glass beads, etc.) and is processed along with and under the same conditions as the associated samples. The LCS is spiked with verified known amounts of analytes or is made of a material containing known and verified amounts of analytes, taken through all preparation and analysis steps along with the field samples. Where there is no preparation taken for an analysis (such as in aqueous volatiles), or when all samples and standards undergo the same preparation and analysis process (such as Phosphorus), a calibration verification standard is reported as the LCS. In some instances where there is no practical clean solid matrix available, aqueous LCS's may be processed for solid matrices; final results may be calculated as mg/kg or ug/kg, assuming 100% solids and a weight equivalent to the aliquot used for the corresponding field samples, to facilitate comparison with the field samples.

24.4.1.3 Certified pre-made reference material purchased from a NIST/A2LA accredited vendor may also be used for the LCS when the material represents the sample matrix or the analyte is not easily spiked (e.g., solid matrix LCS for metals, TDS, etc.).

24.4.1.4 The specific frequency of use for LCS during the analytical sequence is defined in the specific standard operating procedure for each analysis. It is generally one for each batch of sample--not to exceed 20 environmental samples.

24.4.1.5 If the mandated or requested test method, or project requirements, do not specify the spiking components, the laboratory shall spike all reportable components to be reported in the Laboratory Control Sample (and Matrix Spike) where applicable, e.g., no spike of pH. However, in cases where the components interfere with accurate assessment (such as simultaneously spiking chlordane, toxaphene and PCBs in Method 608), the test method has an extremely long list of components or components are incompatible, at a minimum, a representative number of the listed components (see below) shall be used to control the test method. The selected components of each spiking mix shall represent all chemistries, elution patterns and masses, permit specified analytes and other client requested components. However, the laboratory shall ensure that all reported components are used in the spike mixture within a two-year time period.

24.4.1.5.1 For methods that have 1-10 target analytes, spike all components.

24.4.1.5.2 For methods that include 11-20 target analytes, spike at least 10 or 80%, whichever is greater.

24.4.1.5.3 For methods with more than 20 target analytes, spike at least 16 components.

24.4.1.5.4 Exception: Due to analyte incompatibility in pesticides, Toxaphene and Chlordane are only spiked at client request based on specific project needs.

24.4.1.5.5 Exception: Due to analyte incompatibility between the various PCB Aroclors, Aroclors 1016 and 1260 are used for spiking as they cover the range of all of the Aroclors. Specific Aroclors may be used by request on a project-specific basis.

24.5 SAMPLE MATRIX CONTROLS

Table 24-2 Sample Matrix Control

Control Type	Details	
Matrix Spikes (MS)	Use	To assess the effect sample matrix of the spiked sample has on the precision and accuracy of the results generated by the method used;
	Typical Frequency ¹	At a minimum, with each matrix-specific batch of samples processed, an MS is carried through the complete analytical procedure. Unless specified by the client, samples used for spiking are randomly selected and rotated between different client projects. If the mandated or requested test method does not specify the spiking components, the laboratory shall spike all reportable components to be reported in the Laboratory Control Sample and Matrix Spike. Refer to the method SOP for complete details
	Description	Essentially, a sample fortified with a known amount of the test analyte(s).
Surrogate	Use	Measures method performance to sample matrix (organics only).
	Typical Frequency ¹	Are added to all samples, standards, and blanks, for all organic chromatography methods except when the matrix precludes its use or when a surrogate is not available. The recovery of the surrogates is compared to the acceptance limits for the specific method. Poor surrogate recovery may indicate a problem with sample composition and shall be reported, with data qualifiers, to the client whose sample produced poor recovery.
	Description	Are similar to matrix spikes except the analytes are compounds with properties that mimic the analyte of interest and are unlikely to be found in environment samples.
Duplicates ²	Use	For a measure of analytical precision, with each matrix-specific batch of samples processed, a matrix duplicate (MD or DUP) sample, matrix spike duplicate (MSD), or LCS duplicate (LCSD) is carried through the complete analytical procedure.
	Typical Frequency ¹	Duplicate samples are usually analyzed with methods that do not require matrix spike analysis.
	Description	Performed by analyzing two aliquots of the same field sample independently or an additional LCS.
Internal Standards	Use	Are spiked into all environmental and quality control samples (including the initial calibration standards) to monitor the qualitative aspect of organic and some inorganic analytical measurements.
	Typical Frequency ¹	All organic and ICP methods as required by the analytical method.
	Description	Used to correct for matrix effects and to help troubleshoot variability in analytical response and are assessed after data acquisition. Possible sources of poor internal standard response are sample matrix, poor analytical technique or instrument performance.

¹ See the specific analytical SOP for type and frequency of sample matrix control samples.

² LCSD's are normally not performed except when regulatory agencies or client specifications require them. The recoveries for the spiked duplicate samples must meet the same laboratory established recovery limits as the accuracy QC samples. If an LCSD is analyzed both the LCS and LCSD must meet the same recovery criteria and be included in the final report. The precision measurement is reported as "Relative Percent Difference" (RPD). Poor precision between duplicates (except LCS/LCSD) may indicate non-homogeneous matrix or sampling.

24.6 ACCEPTANCE CRITERIA (CONTROL LIMITS)

24.6.1 As mandated by the test method and regulation, each individual analyte in the LCS, MS, or Surrogate Spike is evaluated against the control limits published in the test method. Where there are no established acceptance criteria, the laboratory calculates in-house control limits with the use of control charts or, in some cases, utilizes client project-specific control

limits. When this occurs, the regulatory or project limits will supersede the laboratory's in-house limits.

Note: For methods, analytes, and matrices with very limited data (e.g., unusual matrices not analyzed often), interim limits are established using available data or by analogy to similar methods or matrices.

Note: For Ohio VAP the laboratory must implement Corrective Action procedures to resolve the deviation and limit qualification of the final results. The laboratory is not permitted to deviate from its VAP approved SOP if it intends to attest under affidavit that the "results" are VAP certified. When all corrective actions listed in the SOP have been exhausted, it may be necessary to use technical judgment in which case the decision process and rationale will be presented in the final report and/or affidavit and the data will be noted as 'not VAP certified' on the affidavit.

24.6.2 Once control limits have been established, they are verified, reviewed, and updated if necessary on an annual basis unless the method requires more frequent updating. Control limits are established per method (as opposed to per instrument) regardless of the number of instruments utilized.

24.6.3 Laboratory-generated Percent Recovery acceptance (control) limits are generally established by taking ± 3 Standard Deviations (99% confidence level) from the average recovery of a minimum of 20-30 data points (more points are preferred).

24.6.3.1 Regardless of the calculated limit, the limit should be no tighter than the Calibration Verification (ICV/CCV), (unless the analytical method specifies a tighter limit).

24.6.3.2 In-house limits cannot be any wider than those mandated in a regulated analytical method. Client or contract required control limits are evaluated against the laboratory's statistically derived control limits to determine if the data quality objectives (DQOs) can be achieved. If laboratory control limits are not consistent with DQOs, then alternatives must be considered, such as method improvements or use of an alternate analytical method.

24.6.3.3 The lowest acceptable recovery limit will be 10% (the analyte must be detectable and identifiable). Exception: The lowest acceptable recovery limit for Benzidine will be 5%, and the analyte must be detectable and identifiable.

24.6.3.4 The maximum acceptable recovery limit will be 200%.

24.6.3.5 The maximum acceptable RPD limit will be 30% for organic methods and 20% for inorganic methods. The minimum RPD limit is 10%.

24.6.3.6 If either the high or low end of the control limit changes by $\leq 10\%$ from previous, the control chart is visually inspected and, using professional judgment, they may be left unchanged if there is no affect on laboratory ability to meet the existing limits.

24.6.4 The lab must be able to generate a current listing of their control limits and track when the updates are performed. In addition, the laboratory must be able to recreate historical

control limits. Refer to NC-QA-018, Statistical Evaluation of Data and Development of Control Charts, for details.

24.6.4.1 One example: The QA Department generates a Quality Control Limit Summary that contains tables that summarize the precision and accuracy acceptability limits for analyses. Unless otherwise noted, limits within these tables are laboratory generated. Once reviewed and approved, the limits are entered into LIMS and are effective immediately. The Quality Assurance department maintains an archive of all limits used within the laboratory.

24.6.5 An LCS that is within the acceptance criteria establishes that the analytical system is in control and is used to validate the process. Samples that are analyzed with an LCS with recoveries outside of the acceptance limits may be determined as out of control and should be re-analyzed if possible. If re-analysis is not possible, then the results for all affected analytes for samples within the same batch must be qualified when reported. The internal Corrective Action process (see Section 12) is also initiated if an LCS exceeds the acceptance limits. Sample results may be qualified and reported without re-analysis if:

24.6.5.1 The analyte results are below the reporting limit and the LCS is above the upper control limit.

24.6.5.2 If the analytical results are above the relevant regulatory limit and the LCS is below the lower control limit.

Note: For Ohio VAP the laboratory must implement Corrective Action procedures to resolve the deviation and limit qualification of the final results. The laboratory is not permitted to deviate from its VAP approved SOP if it intends to attest under affidavit that the "results" are VAP certified. When all corrective actions listed in the SOP have been exhausted, it may be necessary to use technical judgment in which case the decision process and rationale will be presented in the final report and/or affidavit and the data will be noted as 'not VAP certified' on the affidavit.

24.6.5.3 Or, for NELAC and Department Of Defense (DOD) work, there are an allowable number of Marginal Exceedances (ME):

- | | |
|--------------------|-------------------------------------|
| • <11 analytes | 0 marginal exceedances are allowed. |
| • 11 – 30 Analytes | 1 marginal exceedance is allowed |
| • 31-50 Analytes | 2 marginal exceedances are allowed |
| • 51-70 Analytes | 3 marginal exceedances are allowed |
| • 71-90 Analytes | 4 marginal exceedances are allowed |
| • > 90 Analytes | 5 marginal exceedances are allowed |

24.6.5.3.1 Marginal exceedances are recovery exceedances between 3 SD and 4 SD from the mean recovery limit (NELAC).

Note: Use of Marginal Exceedances is not permitted for Ohio VAP.

24.6.5.3.2 Marginal exceedances must be random. If the same analyte exceeds the LCS control limit repeatedly, it is an indication of a systematic problem. The source of the error must be located and corrective action taken. The laboratory has a system to monitor marginal exceedances to ensure that they are random.

24.6.5.3.3 Though marginal exceedances may be allowed, the data must still be qualified to indicate it is outside of the normal limits.

24.6.6 If the MS/MSDs do not meet acceptance limits, the MS/MSD and the associated spiked sample is reported with a qualifier for those analytes that do not meet limits. If obvious preparation errors are suspected, or if requested by the client, unacceptable MS/MSDs are reprocessed and re-analyzed to prove matrix interference. A more detailed discussion of acceptance criteria and corrective action can be found in the lab's method SOPs and in Section 12.

24.6.7 If a surrogate standard falls outside the acceptance limits, and if there is not obvious chromatographic matrix interference, re-analyze the sample to confirm a possible matrix effect. If the recoveries confirm or there was obvious chromatographic interference, results are reported from the original analysis and a qualifier is added. If the re-analysis meets surrogate recovery criteria, the second run is reported (or both are reported if requested by the client).

Note: A more detailed discussion of acceptance criteria and corrective action can be found in the laboratory's method SOPs and in Section 12.

24.7 ADDITIONAL PROCEDURES TO ASSURE QUALITY CONTROL

24.7.1 The laboratory has written and approved method SOPs to assure the accuracy of the test method including calibration (see Section 20), use of certified reference materials (see Section 21), and use of PT samples (see Section 15).

24.7.2 A discussion regarding MDLs, Limit of Detection (LOD), and Limit of Quantitation (LOQ) can be found in Section 19.

24.7.3 Use of formulae to reduce data is discussed in the method SOPs and in Section 20.

24.7.4 Selection of appropriate reagents and standards is included in Sections 9 and 21.

24.7.5 A discussion on selectivity of the test is included in Section 5.

24.7.6 Constant and consistent test conditions are discussed in Section 18.

24.7.7 The laboratory sample acceptance policy is included in Section 23.

SECTION 25

REPORTING RESULTS **(NELAC 5.5.10)**

25.1 OVERVIEW

The results of each test are reported accurately, clearly, unambiguously, and objectively in accordance with State and Federal regulations as well as client requirements. Analytical results are issued in a format that is intended to satisfy customer and laboratory accreditation requirements as well as provide the end user with the information needed to properly evaluate the results. Where there is a conflict between client requests and laboratory ethics or regulatory requirements, the laboratory's ethical and legal requirements are paramount, and the laboratory must work with the client during project setup to develop an acceptable solution. Refer to Section 7.

A variety of report formats are available to meet specific needs.

In cases where a client asks for simplified reports, there must be a written request from the client. There still must be enough information that would show any analyses that were out of conformance (QC out of limits) and there should be a reference to a full report that is made available to the client.

Review of reported data is included in Section 19.

25.2 TEST REPORTS

Analytical results are reported in a format that is satisfactory to the client and meets all requirements of applicable accrediting authorities and agencies. A variety of report formats are available to meet specific needs. The report is printed, reviewed, and signed by the appropriate Project Manager. At a minimum, the standard laboratory report shall contain the following information:

25.2.1 A report title with a "Sample Result" header.

25.2.2 Each report cover page printed, which includes the laboratory name, address, and telephone number.

25.2.3 A unique identification of the report (e.g., Work Order number) and on each page an identification in order to ensure the page is recognized as part of the report and a clear identification of the end.

Note: Page numbers of report are represented at the bottom of each page. The report is sequentially paginated. The final page of the report is labeled as "End of Report".

25.2.4 A copy of the Chain-of-Custody (COC).

- Any COCs involved with subcontracting are included.

- Any additional addenda to the report must be treated in a similar fashion so it is a recognizable part of the report and cannot accidentally get separated from the report (e.g., Sampling information).

- 25.2.5** The name and address of client and a project name/number, if applicable.
- 25.2.6** Client project manager or other contact
- 25.2.7** Description and unambiguous identification of the tested sample(s) including the client identification code.
- 25.2.8** Date of receipt of sample, date and time of collection, and date(s) of test preparation and performance, and time of preparation or analysis.
- 25.2.9** Date reported or date of revision, if applicable
- 25.2.10** Method of analysis including method code (EPA, Standard Methods, etc)
- 25.2.11** Reporting limit
- 25.2.12** Method detection limits (if requested)
- 25.2.13** Definition of data qualifiers and reporting acronyms, e.g., ND
- 25.2.14** Sample results
- 25.2.15** QC data consisting of method blank, surrogate, LCS, and MS/MSD recoveries and control limits
- 25.2.16** Condition of samples at receipt including temperature. This may be accomplished in a narrative or by attaching sample login sheets (refer to Section 25.2.4 – Item 3, regarding additional addenda).
- 25.2.17** A statement to the effect that the results relate only to the items tested and the sample as received by the laboratory.
- 25.2.18** A signature and title of the person(s) accepting responsibility for the content of the report and date of issue. Signatories are appointed by the Lab Director.
- 25.2.19** When NELAC accreditation is required, the lab must certify that the test results meet all requirements of NELAC or provide reasons and/or justification if they do not.
- 25.2.20** The laboratory includes a cover page.
- 25.2.21** Where applicable, a narrative to the report that explains the issue(s) and corrective action(s) taken in the event that a specific accreditation or certification requirement was not met.
- 25.2.22** When soil samples are analyzed, a specific identification as to whether soils are reported on a “wet weight” or “dry weight” basis.

25.2.23 Appropriate laboratory certification number for the state of origin of the sample, if applicable.

25.2.24 If only part of the report is provided to the client (client requests some results before all of it is complete), it must be clearly indicated on the report, e.g., partial report, or how your lab identifies it. A complete report must be sent once all of the work has been completed.

25.2.25 Any non-TestAmerica subcontracted analysis results are provided as a separate report on the official letterhead of the subcontractor. All TestAmerica subcontracting is clearly identified on the report as to which laboratory performed a specific analysis.

Note: Refer to the Corporate SOP on Electronic Reporting and Signature Policy CA-L-P-002 for details on internally applying electronic signatures of approval.

25.2.26 Reports for Ohio VAP work require a VAP affidavit be completed and included with the report.

Note: For additional information on Ohio VAP affidavits refer to OAC Rule 3745-300-04 and OAC Rule 3745-300-13(N), effective March 1, 2009.

25.3 REPORTING LEVEL OR REPORT TYPE

The laboratory offers two levels of quality control reporting. Each level, in addition to its own specific requirements, contains all the information provided in the preceding level. The packages provide the following information in addition to the information described above:

- Standard report – all features in Section 25.2
- Expanded deliverable – standard report presented on CLP-like forms and relevant calibration information. All supporting raw data is supplied.

In addition to the various levels of QC packaging, the laboratory also provides reports in diskette deliverable form. Procedures used to ensure client confidentiality are outlined in Section 25.7.

25.3.1 Electronic Data Deliverables (EDDs)

EDDs are routinely offered as part of TestAmerica services. TestAmerica North Canton offers a variety of EDD formats including (but not limited to) ADR, EQUIS, GISKey, Region 5, NJHAZsite, and a wide variety of client specific multi-file, Excel and flat file formats.

EDD specifications are submitted to the IT Department by the PM for review and undergo the contract review process. Once the facility has committed to providing data in a specific electronic format, the coding of the format may need to be performed. This coding is documented and validated. The validation of the code is retained by the IT staff coding the EDD.

EDDs must be subject to a review to ensure their accuracy and completeness. If EDD generation is automated, review may be reduced to periodic screening if the laboratory can demonstrate that it can routinely generate that EDD without errors. Any revisions to the EDD format must be reviewed until it is demonstrated that it can routinely be generated without errors. If the EDD can be reproduced accurately and if all subsequent EDDs can be produced error-free, each EDD does not necessarily require a review.

25.4 SUPPLEMENTAL INFORMATION FOR TEST

The lab identifies any unacceptable QC analyses or any other unusual circumstances or observations such as environmental conditions and any non-standard conditions that may have affected the quality of a result. This is typically in the form of a footnote or a qualifier and/or a narrative explaining the discrepancy in the front of the report.

25.4.1 Numeric results with values outside of the calibration range, either high or low are qualified as 'estimated'.

25.4.2 Where quality system requirements are not met, a statement of compliance/non-compliance with requirements and/or specifications is required, including identification of test results derived from any sample that did not meet NELAC sample acceptance requirements such as improper container, holding time, or temperature.

25.4.3 Where applicable, a statement on the estimated uncertainty of measurements; information on uncertainty is needed when a client's instructions so require.

25.4.4 Opinions and Interpretations - The test report contains objective information, and generally does not contain subjective information such as opinions and interpretations. If such information is required by the client, the Laboratory Director will determine if a response can be prepared. If so, the Laboratory Director will designate the appropriate member of the management team to prepare a response. The response must be fully documented, and reviewed by the Laboratory Director, before release to the client. There may be additional fees charged to the client at this time, as this is a non-routine function of the laboratory.

When opinions or interpretations are included in the report, the laboratory provides an explanation as to the basis upon which the opinions and interpretations have been made. Opinions and interpretations are clearly noted as such and where applicable, a comment should be added suggesting that the client verify the opinion or interpretation with their regulator.

25.5 ENVIRONMENTAL TESTING OBTAINED FROM SUBCONTRACTORS

If the laboratory is not able to provide the client the requested analysis, the samples would be subcontracted following the procedures outlined in the Corporate SOP CA-L-S-002, Subcontracting.

Data reported from analyses performed by a subcontractor laboratory are clearly identified as such on the analytical report provided to the client. Results from a subcontract laboratory outside of the TestAmerica network are reported to the client on the subcontract laboratory's original report stationary and the report includes any accompanying documentation.

25.6 CLIENT CONFIDENTIALITY

In situations involving the transmission of environmental test results by telephone, facsimile, or other electronic means, client confidentiality must be maintained.

TestAmerica will not intentionally divulge to any person (other than the client or any other person designated by the client in writing) any information regarding the services provided by TestAmerica or any information disclosed to TestAmerica by the client. Furthermore, information known to be potentially endangering to national security or an entity's proprietary rights will not be released.

Note: This shall not apply to the extent that the information is required to be disclosed by TestAmerica under the compulsion of legal process. TestAmerica will, to the extent feasible, provide reasonable notice to the client before disclosing the information.

Note: Authorized representatives of an accrediting authority are permitted to make copies of any analyses or records relevant to the accreditation process, and copies may be removed from the laboratory for purposes of assessment.

25.6.1 Report deliverable formats are discussed with each new client. If a client requests that reports be faxed or e-mailed, the reports are faxed with a cover sheet or e-mailed with the following note that includes a confidentiality statement similar to the following:

"Confidentiality Notice: The information contained in this message is intended only for the use of the addressee, and may be confidential and/or privileged. If the reader of this message is not the intended recipient, or the employee or agent responsible to deliver it to the intended recipient, you are hereby notified that any dissemination, distribution or copying of this communication is strictly prohibited. If you have received this communication in error, please notify the sender immediately."

25.7 FORMAT OF REPORTS

The format of reports is designed to accommodate each type of environmental test carried out and to minimize the possibility of misunderstanding or misuse.

25.8 AMENDMENTS TO TEST REPORTS

Corrections, additions, or deletions to reports are only made when justification arises through supplemental documentation. Justification is documented using the laboratory's corrective action system (refer to Section 12).

When the report is re-issued, a notation of "report reissue" is placed on the cover/signature page of the report or at the top of the narrative page with a brief explanation of reason for the reissue and a reference back to the 1st final report generated.

25.9 POLICIES ON CLIENT REQUESTS FOR AMENDMENTS

25.9.1 Policy on Data Omissions or Reporting Limit Increases

Fundamentally, our policy is simply to not omit previously reported results (including data qualifiers) or to not raise reporting limits and report sample results as ND. This policy has few exceptions. Exceptions are:

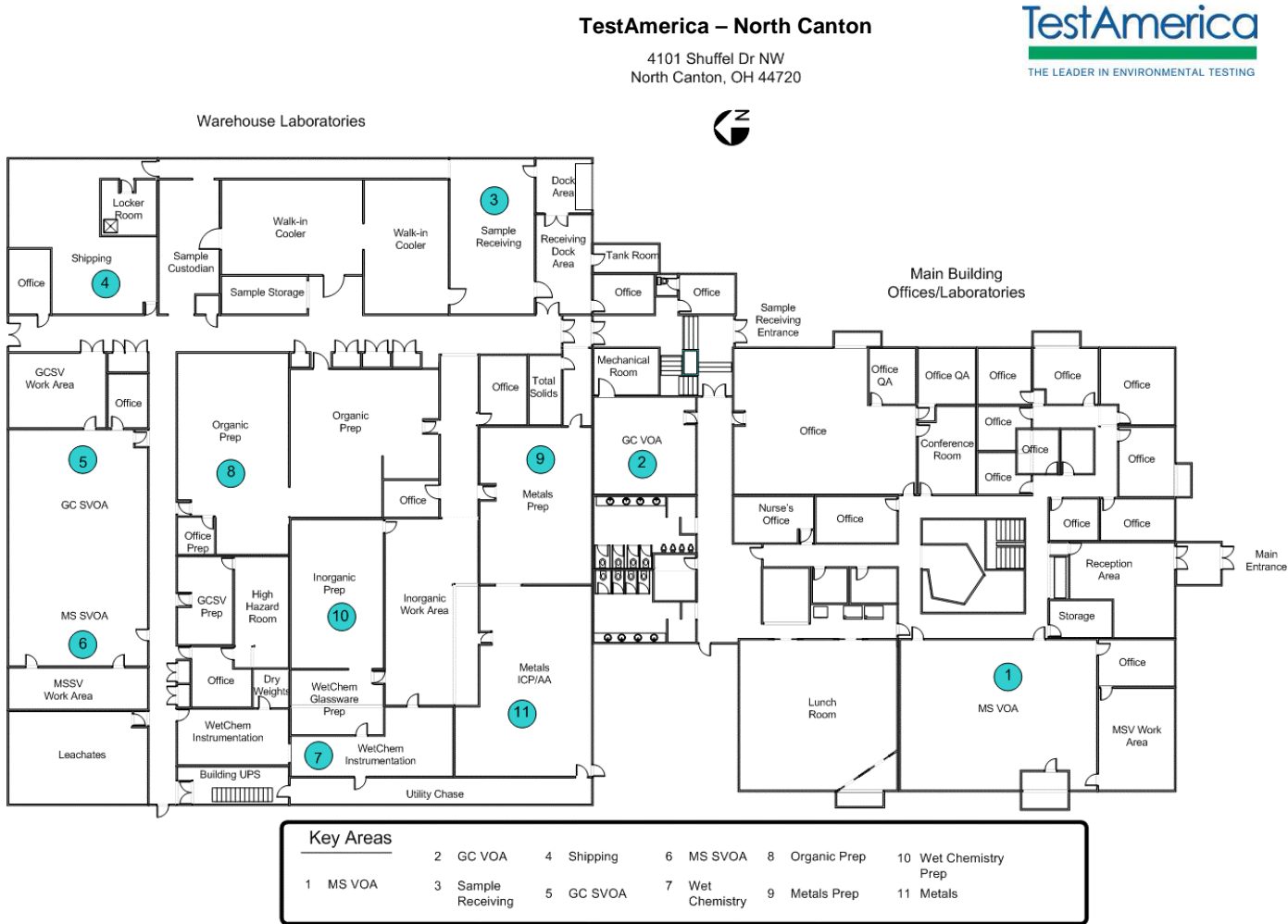
- Laboratory error
- Sample identification is indeterminate (confusion between COC and sample labels).
- An incorrect analysis (not analyte) was requested (e.g., COC lists 8315 but client wanted 8310). A written request for the change is required.
- Incorrect limits reported based on regulatory requirements
- The requested change has absolutely no possible impact on the interpretation of the analytical results and there is no possibility of the change being interpreted as misrepresentation by anyone inside or outside of our company.

25.9.2 Multiple Reports

TestAmerica does not issue multiple reports for the same work order where there is different information on each report (this does not refer to copies of the same report) unless required to meet regulatory needs and approved by QA.

Appendix 1.

Laboratory Floor Plan



Appendix 2. Laboratory Method Listing

Wet Chemistry Methods¹

Analytical Parameters	Matrix	Fields of Testing			
			CWA	RCRA (SW846)	Other
Acidity	Water		305. ² SM 2310 B	--	--
Alkalinity, Bicarbonate, Carbonate	Water		305. ² SM 2320 B		
	Solid		EPA 310.1 ² (M)	--	--
Arsenic (ASV) Anodic Stripping Voltammetry	Water		--	EPA 7063	--
Ash Content	Solid		--	--	ASTM D29-74
Biochemical Oxygen Demand, Carbonaceous	Water		EPA 405.1 SM 5210 B	--	--
Bromide	Water		EPA 300.0A	EPA 9056A	--
	Waste		EPA 300.0A	EPA 9056A	--
	Solid		EPA 300.0A (M)	EPA 9056A	--
Cation-Exchange Capacity	Solid		--	EPA 9081	--
Chemical Oxygen Demand	Water		EPA 410.4 SM 5220D	--	--
	Waste		EPA 410.4	--	--
Chloride	Water		EPA 300.0A EPA 325.2 ²	EPA 9056A EPA 9251	EPA 325.2 ²
	Waste		EPA 300.0A	EPA 9056A	--
	Solid		EPA 300.0A (M)	EPA 9056A EPA 9251(M)	--
Chromium, Hexavalent	Water		EPA 3500-Cr-D	EPA 7196A	--
	Waste		EPA 3500-Cr-D	EPA 7196A	--
	Solid		--	EPA 3060A EPA 7196A	--

¹ Any matrix not listed is not applicable for the associated method

² Removed from 40CFR

Analytical Parameters	Matrix	Fields of Testing			
			CWA	RCRA (SW846)	Other
Specific Conductance	Water		EPA 120.1 SM 2510B	EPA 9050A	--
	Waste		EPA 120.1	EPA 9050A	--
	Solid		--	EPA 9050A	--
Chlorine, Residual	Water		EPA 330.5 ² SM 3500 CL-G	--	--
Cyanide (Amenable)	Water		EPA 335.1 ² SM 4500 CN-G	EPA 9012A	--
	Solid		--	EPA 9012A	--
Cyanide (Total)	Water		SM 4500-CN E EPA 335.4 335.2-CLP-M	EPA 9012A	---
	Waste		--	EPA 9012A	--
	Solid		--	EPA 9012A	--
Cyanide (Weak and Dissociable) (Free)	Water		SM 4500-CN I	--	--
Dissolved Oxygen	Water		360.1 ² SM 4500 O-G	--	--
Flash Point	Waste		--	EPA 1010	ASTM D93-9
	Solid		--	EPA 1010	ASTM D93-9
Fluoride	Water		EPA 300.0A EPA 340.2 ²	EPA 9056A	SM 4500 F-C, ISE
	Waste		EPA 340.2 (M) ² EPA 300.0A (M)	EPA 9056A	--
	Solid		EPA 340.2 (M) ² EPA 300.0A (M)	EPA 9056A	--
Iron, Ferrous & Ferric	Water		SM 3500 FE D	--	--
Hardness	Water		EPA 130.2 ²	--	SM 2340B
Moisture	Solid		---	EPA 160.3 (M) ASTM D2216-90	---
Nitrogen, Ammonia	Water		EPA 350.1	--	EPA 350.2 ²
	Waste		EPA 350.1	--	EPA 350.2 ²
	Solid		EPA 350.1	--	EPA 350.2 ²
	Water		SM 4500 NH ₃ -B (Distillation)	--	--
	Water		SM 4500 NH ₃ -E (Titration)	--	--
	Water		SM 4500 NH ₃ -F (ISE)	--	--

Analytical Parameters	Matrix	Fields of Testing		
		CWA	RCRA (SW846)	Other
Nitrite (NO ₂)	Water	EPA 300.0A	EPA 9056A	--
	Waste	EPA 300.0A (M)	EPA 9056A	--
	Solid	EPA 300.0A (M)	EPA 9056A	--
Nitrate (NO ₃)	Water	EPA 300.0A	EPA 9056A	SM 4500 NO ₃ -E
	Waste	EPA 300.0A (M)	EPA 9056A	--
	Solid	EPA 300.0A (M)	--	--
Nitrate plus Nitrite NO ₂ /NO ₃	Water	EPA 353.2	--	--
	Waste	EPA 353.2	--	--
Total Kjeldahl Nitrogen (TKN)	Water	EPA 351.3	--	SM 4500 NO ₃
	Waste	EPA 351.3	--	--
	Solid	EPA 351.3	--	--
Oil and Grease (Hexane Extractable Material)	Water	EPA 1664A	EPA 9071B	--
	Waste	EPA 1664A	EPA 9071B	--
	Solid	--	EPA 9071B	--
Ortho-phosphate o-PO ₄	Water	EPA 300.0A EPA 365.1	EPA 9056A	SM 4500 P-E
	Waste	EPA 300.0A (M)	EPA 9056A	--
	Solid	EPA 300.0A (M) EPA 365.1	EPA 9056A	--
pH	Water	EPA 150.1 ²	EPA 9040B	EPA 9041
	Waste	SM 4500 H-B	EPA 9045C	--
	Solid	---	EPA 9045C	--
Paint Filter	Water	--	EPA 9095A	--
Phenolics	Water	EPA 420.1	--	--
	Waste	--	EPA 9065	--
	Solid	--	EPA 9065	--
Phosphorus (Total)	Water	EPA 365.1	--	SM 4500 P-E
	Waste	EPA 365.1	--	--
	Solid	EPA 365.1	--	--
Sulfate (SO ₄)	Water	EPA 300.0A EPA 375.4 ²	EPA 9056A EPA 9038	--
	Waste	EPA 300.0A (M) EPA 375.4 ²	EPA 9056A EPA 9038	--
	Solid	EPA 300.0A (M)	EPA 9056A EPA 9038 (M)	--

Analytical Parameters	Matrix	Fields of Testing			
			CWA	RCRA	Other
Sulfide	Water		EPA 376.1 ²	EPA 9030A SM 4500	9030B/9034
Total Organic Carbon (TOC)	Water		EPA 415.1 ²	EPA 9060	SM 5310 D
	Waste		--	EPA 9060	--
	Solid		EPA 415.1 (M)	EPA 9060 (M)	Walkley-Black
Total Organic Halides (TOX)	Water		--	EPA 9020B EPA 9023(EOX)	EPA 450.1
	Waste		--	--	--
	Solid		--	EPA 9020B	--
Total Petroleum Hydrocarbons	Water		EPA 1664A (SGT-HEM)	EPA 9071B	--
	Waste		EPA 1664A (SGT-HEM)	EPA 9071B	--
	Solid		--	EPA 9071B	--
Total Solids	Water		EPA 160.3	--	--
	Waste		EPA 160.3	--	--
	Solid		EPA 160.3 (M)	--	--
Total Dissolved Solids	Water		EPA 160.1	--	2540E
Total Suspended Solids	Water		EPA 160.2	---	2540E
Volatile and Volatile Suspended Solids	Water		EPA 160.4	--	--
Settleable Solids	Water		EPA 160.5	--	--
Turbidity	Water		EPA 180.1	--	--

Methods for Mercury by Cold Vapor Atomic Absorption

Analytical Parameters	Matrix	Fields of Testing			
			CWA	RCRA (SW846)	Other
Mercury (CVAA)	Water		EPA 245.1	EPA 7470A	--
	TCLP Leachate		--	EPA 7470A	--
	Waste		--	EPA 7471A	--
	Solid		EPA 254.5	EPA 7471A	--

Methods for Mercury by Cold Vapor Atomic Fluorescence

Analytical Parameters	Matrix	Fields of Testing			
			CWA	RCRA (SW846)	Other
Mercury, Low Level (CVAFS)	Water		--	--	EPA 1631E

Methods for Metals by ICP and ICPMS

Analytical Parameters	Matrix	Fields of Testing			
			CWA	RCRA (SW846)	Other
Metals by ICP analysis	Water		EPA 200.7	EPA 6010B	---
	Waste		---	EPA 6010B	---
	Solid		EPA 200.7	EPA 6010B	---
Metals by ICPMS analysis	Water		EPA 200.8	EPA 6020	---
	Waste		---	EPA 6020	---
	Solid		EPA 200.8	EPA 6020	---

Metals Sample Preparation Methods

Analytical Parameters	Matrix	Fields of Testing			
			CWA	RCRA (SW846)	Other
Toxicity Characteristic Leaching Procedure (TCLP)	Water		---	EPA 1311	---
	Waste		---	EPA 1311	---
	Solid		---	EPA 1311	---
ICP Metals	Water		EPA 200.7	EPA 3005A EPA 3010A	---
	TCLP Leachate		---	EPA 3010A	---
	Waste		---	EPA 3050B	---
	Solid		---	EPA 3050B	---
ICPMS Metals	Water		EPA 200.8	EPA 3010A	---
	TCLP		---	EPA 3010A	---
	Waste		---	EPA 3050B	---
	Solid		---	EPA 3050B	---
CVAA Mercury	Water		EPA 245.1	EPA 7470A	---
	TCLP Leachate		---	EPA 7470A	---
	Waste		---	EPA 7471A	---
	Solid		---	EPA 7471A	
CVAFS Mercury Low Level	Water		---	---	EPA 1631E

Organic Sample Preparation Methods

Analytical Parameters	Matrix	Fields of Testing			
			CWA	RCRA (SW846)	Other
Volatiles by GC/MS	Water		EPA 624	EPA 5030B	---
	Waste		---	EPA 5030B EPA 5035	---
	Solid		---	EPA 5035 EPA 5035A	---
Halogenated Volatiles by GC	Water		EPA 601	EPA 5030B	---
	Waste		---	EPA 5030B EPA 5035	---
	Solid		---	EPA 5035 EPA 5035A	---
Aromatic Volatiles by GC	Water		EPA 602	EPA 5030B	---
	Waste		---	EPA 5030B EPA 5035	---
	Solid		---	EPA 5035 EPA 5035A	---
Semivolatiles by GC/MS	Water		EPA 625	EPA 3510C EPA 3520C	---
	TCLP Leachate		---	EPA 3510C EPA 3520C	---
	Waste		---	EPA 3550B EPA 3540C EPA 3580A EPA 3541	---
	Solid		---	EPA 3550B EPA 3540C EPA 3541	---
Pesticides/PCBs by GC	Water		EPA 608	EPA 3510C EPA 3520C	---
	TCLP Leachate		---	EPA 3510C EPA 3520C	---
	Waste		---	EPA 3550B EPA 3540C EPA 3580A EPA 3541	---
	Solid		---	EPA 3550B EPA 3540C EPA 3541	---

Analytical Parameters	Matrix	Fields of Testing			
			CWA	RCRA (SW846)	Other
Herbicides by GC	Water		EPA 615	EPA 8151A	---
	Waste		---	EPA 8151A	---
	Solid		---	EPA 8151A	---
Total Petroleum Hydrocarbons (Gasoline Range) by GC	Water		---	EPA 5030B	WI GRO
	Waste		---	EPA 5030B EPA 5035	WI GRO
	Solid		---	EPA 5035 EPA 5035	WI GRO
Total Petroleum Hydrocarbons (Diesel Range) by GC	Water		---	EPA 3510C EPA 3520C	WI DRO
	TCLP Leachate		---	EPA 3510C EPA 3520C	---
	Waste		---	EPA 3550B EPA 3580A	WI DRO
	Solid		---	EPA 3550B	WI DRO

Organic Methods of Analysis

Analytical Parameters	Matrix	Fields of Testing			
			CWA	RCRA (SW846)	Other
Volatiles by GC/MS	Water		EPA 624	EPA 8260B	---
	Waste		---	EPA 8260B	---
	Solid		---	EPA 8260B	---
Halogenated Volatiles by GC	Water		EPA 601	EPA 8021B	---
	Waste		---	EPA 8021B	---
	Solid		---	EPA 8021B	---
Aromatic Volatiles by GC	Water		EPA 602	EPA 8021B	---
	Waste		---	EPA 8021B	---
	Solid		---	EPA 8021B	---
Semivolatiles by GC/MS	Water		EPA 625	EPA 8270C	
	Waste		---	EPA 8270C	---
	Solid		---	EPA 8270C	---
Pesticides/PCBs by GC	Water		EPA 608	Pesticides 8081A PCBs 8082	---
	TCLP Leachate		---	Pesticides 8081A PCBs 8082	---
	Waste		---	Pesticides 8081A PCBs 8082	---
	Solid		---	Pesticides 8081A PCBs 8082	---

Analytical Parameters	Matrix	Fields of Testing			
			CWA	RCRA (SW846)	Other
Phenoxyacid Herbicides by GC	Water		---	EPA 8151A	---
	TCLP Leachate		---	EPA 8151A	---
	Waste		---	EPA 8151A	---
	Solid		---	EPA 8151A	---
Gasoline Range Organics by GC	Water		---	EPA 8015B (M)	WI GRO
	Waste		---	EPA 8015B (M)	---
	Solid		---	EPA 8015B (M)	WI GRO
Total Petroleum Hydrocarbons (Diesel Range) by GC/FID Dissolved Gases RSK-175	Water		---	EPA 8015B (M)	WI DRO
	Waste		---	EPA 8015B (M)	---
	Water		---	---	SOP
Formaldehyde Carbonyl Compounds	Water		---	EPA 8315	---

Appendix 3. Glossary/Acronyms

Glossary

Acceptance Criteria:

Specified limits placed on characteristics of an item, process, or service defined in requirement documents. (ASQC)

Accreditation:

The process by which an agency or organization evaluates and recognizes a laboratory as meeting certain predetermined qualifications or standards, thereby accrediting the laboratory. In the context of the National Environmental Laboratory Accreditation Program (NELAP), this process is a voluntary one. (NELAC)

Accrediting Authority:

The Territorial, State, or Federal Agency having responsibility and accountability for environmental laboratory accreditation and which grants accreditation (NELAC) [1.5.2.3]

Accuracy:

The degree of agreement between an observed value and an accepted reference value. Accuracy includes a combination of random error (precision) and systematic error (bias) components which are due to sampling and analytical operations; a data quality indicator. (QAMS)

Analyst:

The designated individual who performs the “hands-on” analytical methods and associated techniques and who is the one responsible for applying required laboratory practices and other pertinent quality controls to meet the required level of quality. (NELAC)

Assessment:

The evaluation process used to measure or establish the performance, effectiveness, and conformance of an organization and/or its systems to defined criteria (to the standards and requirements of NELAC). (NELAC)

Assessment Criteria:

The measures established by NELAC and applied in establishing the extent to which an applicant is in conformance with NELAC requirements. (NELAC)

Assessment Team:

The group of people authorized to perform the on-site inspection and proficiency testing data evaluation required to establish whether an applicant meets the criteria for NELAP accreditation. (NELAC)

Assessor:

One who performs on-site assessments of accrediting authorities and laboratories' capability and capacity for meeting NELAC requirements by examining the records and other physical evidence for each one of the tests for which accreditation has been requested. (NELAC)

Audit:

A systematic evaluation to determine the conformance to quantitative and qualitative specifications of some operational function or activity.

Batch:

Environmental samples which are prepared and/or analyzed together with the same process and personnel, using the same lot(s) of reagents. A preparation batch is composed of one to 20 environmental samples of the same matrix, meeting the above mentioned criteria and with a maximum time between the start of processing of the first and last sample in the batch to be 24 hours. An analytical batch is composed of prepared environmental samples (extracts, digestates or concentrates) and /or those samples not requiring preparation, which are analyzed together as a group using the same calibration curve or factor. An analytical batch can include samples originating from various environmental matrices and can exceed 20 samples. (NELAC Quality Systems Committee)

Blank:

A sample that has not been exposed to the analyzed sample stream in order to monitor contamination during sampling, transport, storage or analysis. The blank is subjected to the usual analytical and measurement process to establish a zero baseline or background value and is sometimes used to adjust or correct routine analytical results. (ASQC)

Blind Sample:

A sample for analysis with a composition known to the submitter. The analyst/laboratory may know the identity of the sample but not its composition. It is used to test the analyst's or laboratory's proficiency in the execution of the measurement process.

Calibration:

To determine, by measurement or comparison with a standard, the correct value of each scale reading on a meter, instrument, or other device. The levels of the applied calibration standard should bracket the range of planned or expected sample measurements. (NELAC)

Calibration Curve:

The graphical relationship between the known values, such as concentrations, of a series of calibration standards and their instrument response. (NELAC)

Calibration Method:

A defined technical procedure for performing a calibration. (NELAC)

Calibration Standard:

A substance or reference material used to calibrate an instrument (QAMS)

Certified Reference Material (CRM):

A reference material one or more of whose property values are certified by a technically valid procedure, accompanied by or traceable to a certificate or other documentation which is issued by a certifying body. (ISO Guide 30–2.2)

Chain-of-Custody:

An unbroken trail of accountability that ensures the physical security of samples and includes the signatures of all who handle the samples. (NELAC) [5.12.4]

Clean Air Act:

The enabling legislation in 42 U.S.C. 7401 et seq., Public Law 91-604, 84 Stat. 1676 Pub. L. 95-95, 91 Stat., 685 and Pub. L. 95-190, 91 Stat., 1399, as amended, empowering EPA to promulgate air quality standards, monitor and enforce them. (NELAC)

Comprehensive Environmental Response, Compensation and Liability Act (CERCLA/SUPERFUND):

The enabling legislation in 42 U.S.C. 9601-9675 et seq., as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), 42 U.S.C. 9601 et seq., to eliminate the health and environmental threats posed by hazardous waste sites. (NELAC)

Compromised Samples:

Those samples which are improperly sampled, insufficiently documented (chain of custody and other sample records and/or labels), improperly preserved, collected in improper containers, or exceeding holding times when delivered to a laboratory. Under normal conditions, compromised samples are not analyzed. If emergency situation require analysis, the results must be appropriately qualified. (NELAC)

Confidential Business Information (CBI):

Information that an organization designates as having the potential of providing a competitor with inappropriate insight into its management, operation or products. NELAC and its representatives agree to safeguarding identified CBI and to maintain all information identified as such in full confidentiality.

Confirmation:

Verification of the identity of a component through the use of an approach with a different scientific principle from the original method. These may include, but are not limited to:

- Second column confirmation
- Alternate wavelength
- Derivatization
- Mass spectral interpretation
- Alternative detectors or
- Additional Cleanup procedures

(NELAC)

Conformance:

An affirmative indication or judgment that a product or service has met the requirements of the relevant specifications, contract, or regulation; also the state of meeting the requirements. (ANSI/ASQC E4-1994)

Correction:

Actions necessary to correct or repair analysis specific non-conformances. The acceptance criteria for method specific QC and protocols as well as the associated corrective actions. The analyst will most frequently be the one to identify the need for this action as a result of calibration checks and QC sample analysis. No significant action is taken to change behavior, process or procedure.

Corrective Action:

The action taken to eliminate the causes of an existing nonconformity, defect or other undesirable situation in order to prevent recurrence. (ISO 8402)

Data Audit:

A qualitative and quantitative evaluation of the documentation and procedures associated with environmental measurements to verify that the resulting data are of acceptable quality (i.e., that they meet specified acceptance criteria). (NELAC)

Data Reduction:

The process of transforming raw data by arithmetic or statistical calculations, standard curves, concentration factors, etc., and collation into a more useable form. (EPA-QAD)

Deficiency:

An unauthorized deviation from acceptable procedures or practices, or a defect in an item. (ASQC)

Detection Limit:

The lowest concentration or amount of the target analyte that can be identified, measured, and reported with confidence that the analyte concentration is not a false positive value. See Method Detection Limit. (NELAC)

Document Control:

The act of ensuring that documents (and revisions thereto) are proposed, reviewed for accuracy, approved for release by authorized personnel, distributed properly, and controlled to ensure use of the correct version at the location where the prescribed activity is performed. (ASQC)

Duplicate Analyses:

The analyses or measurements of the variable of interest performed identically on two subsamples of the same sample. The results from duplicate analyses are used to evaluate analytical or measurement precision but not the precision of sampling, preservation or storage internal to the laboratory. (EPA-QAD)

Equipment Blank:

Sample of analyte-free media which has been used to rinse common sampling equipment to check effectiveness of decontamination procedures. (NELAC)

External Standard Calibration:

Calibrations for methods that do not utilize internal standards to compensate for changes in instrument conditions.

Federal Insecticide, Fungicide and Rodenticide Act (FIFRA):

The enabling legislation under 7 U.S.C. 135 et seq., as amended, that empowers the EPA to register insecticides, fungicides, and rodenticides. (NELAC)

Federal Water Pollution Control Act (Clean Water Act, CWA):

The enabling legislation under 33 U.S.C. 1251 et seq., Public Law 92-50086 Stat 816, that empowers EPA to set discharge limitations, write discharge permits, monitor, and bring enforcement action for non-compliance. (NELAC)

Field Blank:

Blank prepared in the field by filling a clean container with pure de-ionized water and appropriate preservative, if any, for the specific sampling activity being undertaken (EPA OSWER)

Field of Testing:

NELAC's approach to accrediting laboratories by program, method and analyte. Laboratories requesting accreditation for a program-method-analyte combination or for an up-dated/improved method are required to submit to only that portion of the accreditation process not previously addressed (see NELAC, section 1.9ff). (NELAC)

Finding:

An assessment conclusion that identifies a condition having a significant effect on an item or activity. As assessment finding is normally a deficiency and is normally accompanied by specific examples of the observed condition. (NELAC)

Holding Times (Maximum Allowable Holding Times):

The maximum times that samples may be held prior to analyses and still be considered valid or not compromised. (40 CFR Part 136)

Inspection:

An activity such as measuring, examining, testing, or gauging one or more characteristics of an entity and comparing the results with specified requirements in order to establish whether conformance is achieved for each characteristic. (ANSI/ASQC E4-1994)

Internal Standard:

A known amount of standard added to a test portion of a sample and carried through the entire measurement process as a reference for evaluating and controlling the precision and bias of the applied analytical test method. (NELAC)

Internal Standard Calibration:

Calibrations for methods that utilize internal standards to compensate for changes in instrument conditions.

Instrument Blank:

A clean sample (e.g., distilled water) processed through the instrumental steps of the measurement process; used to determine instrument contamination. (EPA-QAD)

Instrument Response:

Instrument response is normally expressed as either peak area or peak height however it may also reflect a numerical representation of some type of count on a detector (e.g. Photomultiplier tube, or Diode array detector) and is used in this document to represent all types.

Laboratory:

A defined facility performing environmental analyses in a controlled and scientific manner. (NELAC)

Laboratory Control Sample (however named, such as laboratory fortified blank, spiked blank, or QC check sample):

A sample matrix, free from the analytes of interest, spiked with verified known amounts of analytes or a material containing known and verified amounts of analytes, taken through all preparation and analysis steps. Where there is no preparation taken for an analysis (such as in aqueous volatiles), or when all samples and standards undergo the same preparation and analysis process (such as Phosphorus), there is no LCS. It is generally used to establish intra-laboratory or analyst specific precision and bias or to assess the performance of all or a portion of the measurement system.

An LCS must be prepared at a minimum of 1 per batch of 20 or less samples per matrix type per sample extraction or preparation method except for analytes for which spiking solutions are not available such as total suspended solids, total dissolved solids, total volatile solids, total solids, pH, color, odor, temperature, dissolved oxygen or turbidity. The results of these samples must be used to determine batch acceptance.

Note: NELAC standards allow a matrix spike to be used in place of this control as long as the acceptance criteria are as stringent as for the LCS. (NELAC)

Laboratory Duplicate:

Aliquots of a sample taken from the same container under laboratory conditions and processed and analyzed independently. (NELAC)

Least Squares Regression (1st Order Curve):

The least squares regression is a mathematical calculation of a straight line over two axes. The y axis represents the instrument response (or Response ratio) of a standard or sample and the x axis represents the concentration. The regression calculation will generate a correlation coefficient (r) that is a measure of the "goodness of fit" of the regression line to the data. A value of 1.00 indicates a perfect fit. In order to be used for quantitative purposes, r must be greater than or equal to 0.99 for organics and 0.995 for inorganics.

Limit of Detection (LOD):

An estimate of the minimum amount of a substance that an analytical process can reliably detect. An LOD is analyte- and matrix-specific and may be laboratory dependent. (Analytical Chemistry, 55, p.2217, December 1983, modified) See also Method Detection Limit.

Matrix:

The component or substrate that contains the analyte of interest. For purposes of batch and QC requirement determinations, the following matrix distinctions must be used:

Aqueous: Any aqueous sample excluded from the definition of Drinking Water matrix or Saline/Estuarine source. Includes surface water, groundwater, effluents, and TCLP or other extracts.

Drinking Water: any aqueous sample that has been designated as a potable or potential potable water source.

Saline/Estuarine: any aqueous sample from an ocean or estuary, or other salt water source such as the Great Salt Lake.

Non-aqueous Liquid: any organic liquid with ,15% settleable solids.

Biological Tissue: any sample of a biological origin such as fish tissue, shellfish, or plant material. Such samples must be grouped according to origin.

Solids: includes soils, sediments, sludges, and other matrices with .15% settleable solids.

Chemical Waste: a product or by-product of an industrial process that results in a matrix not previously defined.

Air: whole gas or vapor samples including those contained in flexible or rigid wall containers and the extracted concentrated analytes of interest from a gas or vapor that are collected with a sorbant tube, impinger solution, filter, or other device. (NELAC)

Matrix Spike (spiked sample or fortified sample):

Prepared by adding a known mass of target analyte to a specified amount of matrix sample for which an independent estimate of target analyte concentration is available. Matrix spikes are used, for example, to determine the effect of the matrix on a method's recovery efficiency.

Matrix spikes must be performed at a frequency of one in 20 samples per matrix type per sample extraction or preparation method except for analytes for which spiking solutions are not available such as, total suspended solids, total dissolved solids, total volatile solids, total solids, pH, color, odor, temperature, dissolved oxygen or turbidity. The selected sample(s) must be rotated among client samples so that various matrix problems may be noted and/or addressed. Poor performance in a matrix spike may indicate a problem with the sample composition and must be reported to the client whose sample was used for the spike. (QAMS)

Matrix Spike Duplicate (spiked sample or fortified sample duplicate):

A second replicate matrix spike is prepared in the laboratory and analyzed to obtain a measure of the precision of the recovery for each analyte. Matrix spike duplicates or laboratory duplicates must be analyzed at a minimum of 1 in 20 samples per matrix type per sample extraction or preparation method. The laboratory must document their procedure to select the use of an appropriate type of duplicate. The selected sample(s) must be rotated among client samples so that various matrix problems may be noted and/or addressed. Poor performance in the duplicates may indicate a problem with the sample composition and must be reported to the client whose sample was used for the duplicate. (QAMS)

Method Blank:

A sample of a matrix similar to the batch of associated samples (when available) that is free from the analytes of interest and is processed simultaneously with and under the same conditions as samples through all steps of the analytical procedures, and in which no target analytes or interferences are present at concentrations that impact the analytical results for sample analyses. (NELAC)

Method Detection Limit:

The minimum concentration of a substance (an analyte) that can be measured and reported with 99% confidence that the analyte concentration is greater than zero and is determined from analysis of a sample in a given matrix containing the analyte. (40 CFR Part 136, Appendix B)

National Environmental Laboratory Accreditation Conference (NELAC):

A voluntary organization of State and Federal environmental officials and interest groups purposed primarily to establish mutually acceptable standards for accrediting environmental laboratories. A subset of NELAP. (NELAC)

National Environmental Laboratory Accreditation Program (NELAP):

The overall National Environmental Laboratory Accreditation Program of which NELAC is a part. (NELAC)

Negative Control:

Measures taken to ensure that a test, its components, or the environment do not cause undesired effects, or produce incorrect test results. (NELAC)

NELAC Standards:

The plan of procedures for consistently evaluating and documenting the ability of laboratories performing environmental measurements to meet nationally defined standards established by the National Environmental Laboratory Accreditation Conference. (NELAC)

Performance Audit:

The routine comparison of independently obtained qualitative and quantitative measurement system data with routinely obtained data in order to evaluate the proficiency of an analyst or laboratory. (NELAC)

Performance Based Measurement System (PBMS):

A set of processes wherein the data quality needs, mandates or limitations of a program or project are specified and serve as criteria for selecting appropriate test methods to meet those needs in a cost-effective manner. (NELAC)

Positive Control:

Measures taken to ensure that a test and/or its components are working properly and producing correct or expected results from positive test subjects. (NELAC)

Precision:

The degree to which a set of observations or measurements of the same property, obtained under similar conditions, conform to themselves; a data quality indicator. Precision is usually expressed as standard deviation, variance or range, in either absolute or relative terms. (NELAC)

Preservation:

Refrigeration and/or reagents added at the time of sample collection (or later) to maintain the chemical and/or biological integrity of the sample. (NELAC)

Proficiency Testing:

A means of evaluating a laboratory's performance under controlled conditions relative to a given set of criteria through analysis of unknown samples provided by an external source. (NELAC) [2.1]

Proficiency Testing Program:

The aggregate of providing rigorously controlled and standardized environmental samples to a laboratory for analysis, reporting of results, statistical evaluation of the results and the collective demographics and results summary of all participating laboratories. (NELAC)

Proficiency Test Sample (PT):

A sample, the composition of which is unknown to the analyst and is provided to test whether the analyst/laboratory can produce analytical results within specified acceptance criteria. (QAMS)

Quality Assurance:

An integrated system of activities involving planning, quality control, quality assessment, reporting and quality improvement to ensure that a product or service meets defined standards of quality with a stated level of confidence. (QAMS)

Quality Assurance [Project] Plan (QAPP):

A formal document describing the detailed quality control procedures by which the quality requirements defined for the data and decisions pertaining to a specific project are to be achieved. (EAP-QAD)

Quality Control:

The overall system of technical activities which purpose is to measure and control the quality of a product or service so that it meets the needs of users. (QAMS)

Quality Control Sample:

An uncontaminated sample matrix spiked with known amounts of analytes from a source independent from the calibration standards. It is generally used to establish intra-laboratory or analyst specific precision and bias or to assess the performance of all or a portion of the measurement system. (EPA-QAD)

Quality Manual:

A document stating the management policies, objectives, principles, organizational structure and authority, responsibilities, accountability, and implementation of an agency, organization, or laboratory, to ensure the quality of its product and the utility of its product to its users. (NELAC)

Quality System:

A structured and documented management system describing the policies, objectives, principles, organizational authority, responsibilities, accountability, and implementation plan of an organization for ensuring quality in its work processes, products (items), and services. The quality system provides the framework for planning, implementing, and assessing work performed by the organization and for carrying out required QA and QC (ANSI/ASQC-E-41994)

Quantitation Limits:

The maximum or minimum levels, concentrations, or quantities of a target variable (e.g., target analyte) that can be quantified with the confidence level required by the data user. (NELAC)

Range:

The difference between the minimum and the maximum of a set of values. (EPA-QAD)

Reagent Blank (method reagent blank):

A sample consisting of reagent(s), without the target analyte or sample matrix, introduced into the analytical procedure at the appropriate point and carried through all subsequent steps to determine the contribution of the reagents and of the involved analytical steps. (QAMS)

Reference Material:

A material or substance one or more properties of which are sufficiently well established to be used for the calibration of an apparatus, the assessment of a measurement method, or for assigning values to materials. (ISO Guide 30-2.1)

Reference Method:

A method of known and documented accuracy and precision issued by an organization recognized as competent to do so. (NELAC)

Reference Standard:

A standard, generally of the highest metrological quality available at a given location, from which measurements made at that location are derived. (VIM-6.0-8)

Replicate Analyses:

The measurements of the variable of interest performed identically on two or more sub-samples of the same sample within a short time interval. (NELAC)

Report Limit (RL):

The laboratory nominal Quantitation Limit (QL) or the level of sensitivity required by the client but not lower than the LOD. Reporting limits are easily accessible via LIMS (QC Browser program).

Requirement:

Denotes a mandatory specification; often designated by the term "shall". (NELAC)

Resource Conservation and Recovery Act (RCRA):

The enabling legislation under 42 USC 321 et seq. (1976), that gives EPA the authority to control hazardous waste from the "cradle-to-grave", including its generation, transportation, treatment, storage, and disposal. (NELAC)

Safe Drinking Water Act (SDWA):

The enabling legislation, 42 USC 300f et seq. (1974), (Public Law 93-523), that requires the EPA to protect the quality of drinking water in the U.S. by setting maximum allowable contaminant levels, monitoring, and enforcing violations. (NELAC)

Sample Duplicate:

Two samples taken from and representative of the same population and carried through all steps of the sampling and analytical procedures in an identical manner. Duplicate samples are used to assess variance of the total method including sampling and analysis. (EPA-QAD)

Second Order Polynomial Curve (Quadratic): The 2nd order curves are a mathematical calculation of a slightly curved line over two axis. The y axis represents the instrument response (or Response ratio) of a standard or sample and the x axis represents the concentration. The 2nd order regression will generate a coefficient of determination (COD or r^2) that is a measure of the "goodness of fit" of the quadratic curvature the data. A value of 1.00

indicates a perfect fit. In order to be used for quantitative purposes, r^2 must be greater than or equal to 0.99.

Selectivity:

(Analytical chemistry) the capability of a test method or instrument to respond to a target substance of constituent in the presence of non-target substances. (EPA-QAD)

Sensitivity:

The capability of a method or instrument to discriminate between measurement responses representing different levels (e.g., concentrations) of a variable of interest. (NELAC)

Spike:

A known mass of target analyte added to a blank, sample or sub-sample; used to determine recovery efficiency or for other quality control purposes.

If the mandated or requested test method does not specify the spiking components, the laboratory shall spike all reportable components to be reported in the Laboratory Control Sample and Matrix Spike. However, in cases where the components interfere with accurate assessment (such as simultaneously spiking chlordane, toxaphene and PCBs in Method 608), the test method has an extremely long list of components or components are incompatible, a representative number (at a minimum 10%) of the listed components may be used to control the test method. The selected components of each spiking mix shall represent all chemistries, elution patterns and masses permit specified analytes and other client requested components. However, the laboratory shall ensure that all reported components are used in the spike mixture within a two-year time period. (NELAC)

Standard:

The document describing the elements of laboratory accreditation that has been developed and established within the consensus principles of NELAC and meets the approval requirements of NELAC procedures and policies. (ASQC)

Standard Operating Procedures (SOPs):

A written document which details the method of an operation, analysis, or action whose techniques and procedures are thoroughly prescribed and which is accepted as the method for performing certain routine or repetitive tasks. (QAMS)

Standardized Reference Material (SRM):

A certified reference material produced by the U.S. National Institute of Standards and Technology or other equivalent organization and characterized for absolute content, independent of analytical method. (EPA-QAD)

Supervisor (however named):

The individual(s) designated as being responsible for a particular area or category of scientific analysis. This responsibility includes direct day-to-day supervision of technical employees, supply and instrument adequacy and upkeep, quality assurance/quality control duties, and ascertaining that technical employees have the required balance of education, training and experience to perform the required analyses. (NELAC)

Surrogate:

A substance with properties that mimic the analyte of interest. It is unlikely to be found in environment samples and is added to them for quality control purposes.

Surrogate compounds must be added to all samples, standards, and blanks, for all organic chromatography methods except when the matrix precludes its use or when a surrogate is not available. Poor surrogate recovery may indicate a problem with sample composition and must be reported to the client whose sample produced poor recovery. (QAMS)

Systems Audit (also Technical Systems Audit):

A thorough, systematic, qualitative on-site assessment of the facilities, equipment, personnel, training, procedures, record keeping, data validation, data management, and reporting aspects of a total measurement system. (EPA-QAD)

Technical Director:

Individuals(s) who has overall responsibility for the technical operation of the environmental testing laboratory. (NELAC)

Test:

A technical operation that consists of the determination of one or more characteristics or performance of a given product, material, equipment, organism, physical phenomenon, process, or service according to a specified procedure. The result of a test is normally recorded in a document sometimes called a test report or a test certificate. (ISO/IEC Guide 2-12.1, amended)

Test Method:

An adoption of a scientific technique for a specific measurement problem, as documented in a laboratory SOP. (NELAC)

Toxic Substances Control Act (TSCA):

The enabling legislation in 15 USC 2601 et seq., (1976) that provides for testing, regulating, and screening all chemicals produced or imported into the United States for possible toxic effects prior to commercial manufacture. (NELAC)

Traceability:

The property of a result of a measurement whereby it can be related to appropriate standards, generally international or national standards, through an unbroken chain of comparisons. (VIM-6.12)

Uncertainty:

A parameter associated with the result of a measurement that characterizes the dispersion of the value that could reasonably be attributed to the measured value.

United States Environmental Protection Agency (EPA):

The Federal governmental agency with responsibility for protecting public health and safeguarding and improving the natural environment (i.e., the air, water, and land) upon which human life depends. (US-EPA)

Validation:

The process of substantiating specified performance criteria. (EPA-QAD)

Verification:

Confirmation by examination and provision of evidence that specified requirements have been met. (NELAC)

Note: In connection with the management of measuring equipment, verification provides a means for checking that the deviations between values indicated by a measuring instrument and corresponding known values of a measured quantity are consistently smaller than the maximum allowable error defined in a standard, regulation or specification peculiar to the management of the measuring equipment. The result of verification leads to a decision either to restore in service, to perform adjustment, to repair, to downgrade, or to declare obsolete. In all cases, it is required that a written trace of the verification performed must be kept on the measuring instrument's individual record.

Acronyms

BS	Blank Spike
BSD	Blank Spike Duplicate
CAR	Corrective Action Report
CCV	Continuing Calibration Verification
CF	Calibration Factor
CFR	Code of Federal Regulations
COC	Chain of Custody
CRS	Change Request Form
DOC	Demonstration of Capability
DQO	Data Quality Objectives
DU	Duplicate
DUP	Duplicate
EHS	Environment, Health and Safety
EPA	Environmental Protection Agency
GC	Gas Chromatography
GC/MS	GasChromatography/Mass Spectrometry
HPLC	High Performance Liquid Chromatography
ICP	Inductively Coupled Plasma Atomic Emission Spectroscopy
ICV	Initial Calibration Verification
IDL	Instrument Detection Limit
IH	Industrial Hygiene
IS	Internal Standard
LCS	Laboratory Control Sample
LCSD	Laboratory Control Sample Duplicate
LIMS	Laboratory Information Management System
MDL	Method Detection Limit
MS	Matrix Spike
MSD	Matrix Spike Duplicate
MSDS	Material Safety Data Sheet
NELAC	National Environmental Laboratory Accreditation Conference
NELAP	National Environmental Laboratory Accreditation Program
PT	Performance Testing
QAM	Quality Assurance Manual
QA/QC	Quality Assurance / Quality Control
QAPP	Quality Assurance Project Plan
RF	Response Factor
RPD	Relative Percent Difference
RSD	Relative Standard Deviation
SD	Standard Deviation
SOP	Standard Operating Procedure
TAT	Turn-Around Time
VOA	Volatiles
VOC	Volatile organic Compound

Appendix 4. Laboratory Certifications, Accreditations, Validations

TestAmerica North Canton maintains certifications, accreditations, certifications, and validations with numerous state and national entities. Programs vary but may include on-site audits, reciprocal agreements with another entity, performance testing evaluations, review of the QA Manual, Standard Operating Procedures, Method Detection Limits, training records, etc. At the time of this QA Manual revision, the laboratory has accreditation/certification/licensing with the following organizations:

Organization	Certificate Number	Organization	Certificate Number
California	01144CA	Nevada	OH-00048208A
Connecticut	PH-0590	New Jersey	OH001
Florida	E87225	New York	10975
Georgia	---	OVAP	CL0024
Illinois	001298	Pennsylvania	68-00340
Kansas	E-10336	US ACE (Army)	---
Kentucky Underground Storage Tank Program	0058	USDA (Dept.of Agriculture)	P330-08-00123
Minnesota	039-999-348	West Virginia	210
DoD - ACLASS	ADE-1437---	Wisconsin	999518190

The certificates and parameter lists (which may differ) for each organization may be found on the corporate web site, the laboratory's public server, the final report review table, and in the following offices: QA, Marketing, and Project Management.

ATTACHMENT B

CRS TCL 4.2 VOCs
Matrix: Soil

Method: SW846 8260B							Check				Spike		
#	Compound	RL	Units	MDL	Units	T A	LCL	UCL	RPD	T A	LCL	UCL	RPD
11	Acetone	20	ug/kg	6.3	ug/kg	Y	58	130	30	Y	10	200	66
196	Benzene	5	ug/kg	0.23	ug/kg	C Y	75	129	20	C Y	55	138	20
323	Bromodichloromethane	5	ug/kg	0.28	ug/kg	Y	72	125	30	Y	47	131	51
340	Bromoform	5	ug/kg	0.33	ug/kg	Y	43	149	30	Y	26	141	64
343	Bromomethane	5	ug/kg	0.54	ug/kg	Y	24	152	30	Y	15	152	72
372	2-Butanone	20	ug/kg	1.4	ug/kg	Y	27	200	46	Y	21	195	60
459	Carbon disulfide	5	ug/kg	0.44	ug/kg	Y	50	137	30	Y	27	149	73
463	Carbon tetrachloride	5	ug/kg	0.37	ug/kg	Y	57	137	30	Y	32	143	68
521	Chlorobenzene	5	ug/kg	0.33	ug/kg	C Y	75	127	22	C Y	49	139	22
535	Dibromochloromethane	5	ug/kg	0.55	ug/kg	Y	49	135	30	Y	44	135	61
550	Chloroethane	5	ug/kg	0.86	ug/kg	Y	31	144	30	Y	32	140	66
569	Chloroform	5	ug/kg	0.29	ug/kg	Y	73	115	30	Y	59	128	46
574	Chloromethane	5	ug/kg	0.41	ug/kg	Y	15	136	30	Y	28	130	81
669	Cyclohexane	10	ug/kg	0.33	ug/kg	Y	50	150	20	Y	50	150	20
539	1,2-Dibromo-3-chloropropane	10	ug/kg	1.3	ug/kg	Y	50	150	30	Y	50	150	20
870	1,2-Dibromoethane	5	ug/kg	0.5	ug/kg	Y	50	150	30	Y	50	150	20
904	1,2-Dichlorobenzene	5	ug/kg	0.36	ug/kg	Y	50	150	30	Y	50	150	20
907	1,3-Dichlorobenzene	5	ug/kg	0.35	ug/kg	Y	50	150	20	Y	50	150	20
910	1,4-Dichlorobenzene	5	ug/kg	0.66	ug/kg	Y	50	150	20	Y	50	150	20
924	Dichlorodifluoromethane	5	ug/kg	0.5	ug/kg	Y	50	150	20	Y	50	150	20
933	1,1-Dichloroethane	5	ug/kg	0.36	ug/kg	Y	77	119	30	Y	56	130	54
936	1,2-Dichloroethane	5	ug/kg	0.34	ug/kg	Y	78	121	30	Y	56	126	38
948	cis-1,2-Dichloroethene	5	ug/kg	0.36	ug/kg	Y	77	114	30	Y	48	127	52
950	trans-1,2-Dichloroethene	5	ug/kg	0.41	ug/kg	Y	68	117	30	Y	47	127	58
943	1,1-Dichloroethene	5	ug/kg	0.52	ug/kg	C Y	55	142	27	C Y	43	147	27
986	1,2-Dichloropropane	5	ug/kg	0.69	ug/kg	Y	78	116	30	Y	54	125	43
998	cis-1,3-Dichloropropene	5	ug/kg	0.34	ug/kg	Y	71	125	30	Y	30	138	49
1000	trans-1,3-Dichloropropene	5	ug/kg	0.54	ug/kg	Y	67	125	30	Y	34	134	57
1332	Ethylbenzene	5	ug/kg	0.26	ug/kg	Y	79	114	30	Y	36	133	72
1515	2-Hexanone	20	ug/kg	0.63	ug/kg	Y	29	200	41	Y	20	190	70
1578	Isopropylbenzene	5	ug/kg	0.16	ug/kg	Y	50	150	20	Y	50	150	20
1774	Methyl acetate	10	ug/kg	1.4	ug/kg	Y	50	150	20	Y	50	150	20
1799	Methylcyclohexane	10	ug/kg	0.31	ug/kg	Y	50	150	20	Y	50	150	20
1811	Methylene chloride	5	ug/kg	0.67	ug/kg	Y	58	130	30	Y	45	129	49
1845	4-Methyl-2-pentanone	20	ug/kg	0.54	ug/kg	Y	68	142	60	Y	42	143	60
2772	Methyl tert-butyl ether	20	ug/kg	0.43	ug/kg	Y	70	130	30	Y	70	130	30
2355	Styrene	5	ug/kg	0.15	ug/kg	Y	80	114	30	Y	23	136	65
2439	1,1,2,2-Tetrachloroethane	5	ug/kg	0.34	ug/kg	Y	70	133	30	Y	33	162	90
2445	Tetrachloroethene	5	ug/kg	0.52	ug/kg	Y	72	120	30	Y	31	137	81
2489	Toluene	5	ug/kg	0.27	ug/kg	C Y	71	130	24	C Y	46	147	24
2515	1,2,4-Trichlorobenzene	5	ug/kg	0.27	ug/kg	Y	50	150	20	Y	50	150	20
2518	1,1,1-Trichloroethane	5	ug/kg	0.56	ug/kg	Y	67	123	30	Y	48	132	57
2522	1,1,2-Trichloroethane	5	ug/kg	0.39	ug/kg	Y	82	116	30	Y	58	128	52
2525	Trichloroethene	5	ug/kg	0.42	ug/kg	C Y	70	131	23	C Y	46	143	23
1428	Trichlorofluoromethane	5	ug/kg	0.34	ug/kg	Y	50	150	20	Y	50	150	20
2566	1,1,2-Trichloro-1,2,2-trifluoroethane	5	ug/kg	1.3	ug/kg	Y	50	150	30	Y	70	130	30
2613	Vinyl chloride	5	ug/kg	0.39	ug/kg	Y	24	152	30	Y	30	136	80
2627	Xylenes (total)	10	ug/kg	0.67	ug/kg	Y	80	114	30	Y	33	135	78
337	4-Bromofluorobenzene					X Y	47	158		X Y	47	158	
2735	1,2-Dichloroethane-d4					X Y	61	130		X Y	61	130	
2740	Toluene-d8					X Y	60	143		X Y	60	143	
2863	Dibromofluoromethane					X Y	59	138		X Y	59	138	

CRS TCL 4.2 VOCs
Matrix: Water

#	Method: Compound	RL	Units	MDL	Units	T	A	Check			T	A	Spike		
								LCL	UCL	RPD			LCL	UCL	RPD
11	Acetone	10	ug/L	1.1	ug/L	Y		22	200	95	Y		45	128	30
196	Benzene	1	ug/L	0.13	ug/L	C	Y	80	116	20	C	Y	78	118	20
323	Bromodichloromethane	1	ug/L	0.15	ug/L	Y		87	130	30	Y		80	146	30
340	Bromoform	1	ug/L	0.64	ug/L	Y		76	150	30	Y		58	176	30
343	Bromomethane	1	ug/L	0.41	ug/L	Y		64	129	30	Y		55	145	30
372	2-Butanone	10	ug/L	0.57	ug/L	Y		28	237	65	Y		71	123	30
459	Carbon disulfide	1	ug/L	0.13	ug/L	Y		73	139	30	Y		69	138	41
463	Carbon tetrachloride	1	ug/L	0.13	ug/L	Y		75	149	30	Y		63	176	30
521	Chlorobenzene	1	ug/L	0.15	ug/L	C	Y	76	117	20	C	Y	76	117	20
535	Dibromochloromethane	1	ug/L	0.18	ug/L	Y		81	138	30	Y		71	158	30
550	Chloroethane	1	ug/L	0.29	ug/L	Y		66	126	30	Y		59	142	30
569	Chloroform	1	ug/L	0.16	ug/L	Y		84	128	30	Y		83	141	30
574	Chloromethane	1	ug/L	0.3	ug/L	Y		48	123	30	Y		40	137	39
669	Cyclohexane	1	ug/L	0.12	ug/L	Y		70	130	30	Y		70	130	30
539	1,2-Dibromo-3-chloropropane	2	ug/L	0.67	ug/L	Y		70	130	30	Y		70	130	30
870	1,2-Dibromoethane	1	ug/L	0.24	ug/L	Y		70	130	30	Y		70	130	30
904	1,2-Dichlorobenzene	1	ug/L	0.13	ug/L	Y		70	130	30	Y		70	130	30
907	1,3-Dichlorobenzene	1	ug/L	0.14	ug/L	Y		70	130	30	Y		70	130	30
910	1,4-Dichlorobenzene	1	ug/L	0.13	ug/L	Y		70	130	30	Y		70	130	30
924	Dichlorodifluoromethane	1	ug/L	0.31	ug/L	Y		70	130	30	Y		70	130	30
933	1,1-Dichloroethane	1	ug/L	0.15	ug/L	Y		86	123	30	Y		88	127	30
936	1,2-Dichloroethane	1	ug/L	0.22	ug/L	Y		79	136	30	Y		71	160	30
948	cis-1,2-Dichloroethene	1	ug/L	0.17	ug/L	Y		85	113	30	Y		87	114	30
950	trans-1,2-Dichloroethene	1	ug/L	0.19	ug/L	Y		80	120	30	Y		85	116	30
943	1,1-Dichloroethene	1	ug/L	0.19	ug/L	C	Y	63	130	20	C	Y	62	130	20
986	1,2-Dichloropropane	1	ug/L	0.18	ug/L	Y		82	115	30	Y		87	114	30
998	cis-1,3-Dichloropropene	1	ug/L	0.14	ug/L	Y		84	130	30	Y		82	130	30
1000	trans-1,3-Dichloropropene	1	ug/L	0.19	ug/L	Y		84	130	30	Y		73	147	30
1332	Ethylbenzene	1	ug/L	0.17	ug/L	Y		86	116	30	Y		86	132	30
1515	2-Hexanone	10	ug/L	0.41	ug/L	Y		35	200	52	Y		81	128	30
1578	Isopropylbenzene	1	ug/L	0.13	ug/L	Y		70	130	30	Y		70	130	30
1774	Methyl acetate	10	ug/L	0.38	ug/L	Y		70	130	30	Y		70	130	30
1799	Methylcyclohexane	1	ug/L	0.13	ug/L	Y		70	130	30	Y		70	130	30
1811	Methylene chloride	1	ug/L	0.33	ug/L	Y		78	118	30	Y		82	115	30
1845	4-Methyl-2-pentanone	10	ug/L	0.32	ug/L	Y		78	141	32	Y		82	135	30
2772	Methyl tert-butyl ether	5	ug/L	0.17	ug/L	Y		70	130	30	Y		70	130	30
2355	Styrene	1	ug/L	0.11	ug/L	Y		85	117	30	Y		83	120	30
2439	1,1,2,2-Tetrachloroethane	1	ug/L	0.18	ug/L	Y		85	118	30	Y		88	116	30
2445	Tetrachloroethene	1	ug/L	0.29	ug/L	Y		88	113	30	Y		85	121	30
2489	Toluene	1	ug/L	0.13	ug/L	C	Y	74	119	20	C	Y	70	119	20
2515	1,2,4-Trichlorobenzene	1	ug/L	0.15	ug/L	Y		70	130	30	Y		70	130	30
2518	1,1,1-Trichloroethane	1	ug/L	0.22	ug/L	Y		78	140	30	Y		71	162	30
2522	1,1,2-Trichloroethane	1	ug/L	0.27	ug/L	Y		83	122	30	Y		86	129	30
2525	Trichloroethene	1	ug/L	0.17	ug/L	C	Y	75	122	20	C	Y	62	130	20
1428	Trichlorofluoromethane	1	ug/L	0.21	ug/L	Y		70	130	30	Y		70	130	30
2566	1,1,2-Trichloro-1,2,2-trifluoroethane	1	ug/L	0.28	ug/L	Y		70	130	30	Y		70	130	30
2613	Vinyl chloride	1	ug/L	0.22	ug/L	Y		61	120	30	Y		88	126	30
2627	Xylenes (total)	2	ug/L	0.28	ug/L	Y		87	116	30	Y		89	121	30
337	4-Bromofluorobenzene					X	Y	74	116		X	Y	74	116	
2735	1,2-Dichloroethane-d4					X	Y	61	128		X	Y	61	128	
2740	Toluene-d8					X	Y	76	110		X	Y	76	110	
2863	Dibromofluoromethane					X	Y	73	122		X	Y	73	122	

TCL 4.2 + DCBs & 124-TCB

Matrix: Water
CRS SVOCs

#	Method: Compound	RL	Units	MDL	Units	T A	Check			T A	Spike		
							LCL	UCL	RPD		LCL	UCL	RPD
1	Acenaphthene	0.2	ug/L	0.1	ug/L	C Y	40	110	30	C Y	36	110	30
5	Acenaphthylene	0.2	ug/L	0.1	ug/L	Y	43	110	30	Y	39	110	30
24	Acetophenone	1	ug/L	0.34	ug/L	Y	50	130	30	Y	50	130	30
122	Anthracene	0.2	ug/L	0.1	ug/L	Y	54	114	30	Y	46	110	30
158	Atrazine	1	ug/L	0.34	ug/L	Y	50	130	30	Y	50	130	30
3398	Benzaldehyde	1	ug/L	0.39	ug/L	Y	10	130	30	Y	10	130	30
202	Benzo(a)anthracene	0.2	ug/L	0.1	ug/L	Y	55	115	30	Y	52	110	30
205	Benzo(b)fluoranthene	0.2	ug/L	0.1	ug/L	Y	43	122	30	Y	33	114	30
208	Benzo(k)fluoranthene	0.2	ug/L	0.1	ug/L	Y	43	124	30	Y	32	121	30
210	Benzo(ghi)perylene	0.2	ug/L	0.1	ug/L	Y	45	120	30	Y	34	116	30
211	Benzo(a)pyrene	0.2	ug/L	0.1	ug/L	Y	43	116	30	Y	33	110	30
3474	1,1'-Biphenyl	1	ug/L	0.8	ug/L	Y	50	130	30	Y	50	130	30
289	bis(2-Chloroethoxy)methane	1	ug/L	0.32	ug/L	Y	39	110	30	Y	35	110	30
293	bis(2-Chloroethyl) ether	1	ug/L	0.1	ug/L	Y	34	113	30	Y	27	110	30
302	bis(2-Ethylhexyl) phthalate	2	ug/L	0.8	ug/L	Y	36	163	30	Y	40	140	30
348	4-Bromophenyl phenyl ether	2	ug/L	0.8	ug/L	Y	51	114	30	Y	42	113	30
403	Butyl benzyl phthalate	1	ug/L	0.8	ug/L	Y	53	126	30	Y	51	121	30
5101	Caprolactam	5	ug/L	0.8	ug/L	Y	50	130	30	Y	50	130	30
2751	Carbazole	1	ug/L	0.28	ug/L	Y	53	120	30	Y	49	114	30
518	4-Chloroaniline	2	ug/L	0.8	ug/L	Y	10	110	30	Y	10	110	30
578	4-Chloro-3-methylphenol	2	ug/L	0.8	ug/L	C Y	39	110	30	C Y	33	110	30
589	2-Chloronaphthalene	1	ug/L	0.1	ug/L	Y	39	110	30	Y	34	110	30
600	2-Chlorophenol	1	ug/L	0.29	ug/L	C Y	27	110	30	C Y	26	110	30
602	4-Chlorophenyl phenyl ether	2	ug/L	0.3	ug/L	Y	50	115	30	Y	43	113	30
633	Chrysene	0.2	ug/L	0.1	ug/L	Y	55	115	30	Y	52	111	30
860	Dibenz(a,h)anthracene	0.2	ug/L	0.1	ug/L	Y	46	122	30	Y	35	118	30
863	Dibenzofuran	1	ug/L	0.1	ug/L	Y	46	111	30	Y	41	110	30
891	Di-n-butyl phthalate	1	ug/L	0.67	ug/L	Y	55	122	30	Y	50	117	30
904	1,2-Dichlorobenzene	1	ug/L	0.29	ug/L	Y	23	110	30	Y	22	110	30
907	1,3-Dichlorobenzene	1	ug/L	0.8	ug/L	Y	19	110	30	Y	19	110	30
910	1,4-Dichlorobenzene	1	ug/L	0.34	ug/L	C Y	19	110	30	C Y	17	110	30
918	3,3'-Dichlorobenzidine	5	ug/L	0.37	ug/L	Y	19	110	30	Y	10	110	30
971	2,4-Dichlorophenol	2	ug/L	0.8	ug/L	Y	33	110	30	Y	30	110	30
1082	Diethyl phthalate	1	ug/L	0.6	ug/L	Y	33	134	30	Y	33	130	30
1145	2,4-Dimethylphenol	2	ug/L	0.8	ug/L	Y	12	110	30	Y	11	110	30
1149	Dimethyl phthalate	1	ug/L	0.29	ug/L	Y	15	143	30	Y	36	124	30
1167	4,6-Dinitro-2-methylphenol	5	ug/L	2.4	ug/L	Y	28	112	30	Y	25	110	30
1187	2,4-Dinitrophenol	5	ug/L	2.4	ug/L	Y	17	112	30	Y	11	119	30
1191	2,4-Dinitrotoluene	5	ug/L	0.27	ug/L	C Y	52	123	30	C Y	46	119	30
1193	2,6-Dinitrotoluene	5	ug/L	0.8	ug/L	Y	52	119	30	Y	48	115	30
1162	Di-n-octyl phthalate	1	ug/L	0.8	ug/L	Y	44	128	30	Y	36	124	30
1414	Fluoranthene	0.2	ug/L	0.1	ug/L	Y	54	122	30	Y	53	111	30
1417	Fluorene	0.2	ug/L	0.1	ug/L	Y	47	112	30	Y	43	110	30
1482	Hexachlorobenzene	0.2	ug/L	0.1	ug/L	Y	51	112	30	Y	40	113	30
1489	Hexachlorobutadiene	1	ug/L	0.27	ug/L	Y	13	110	30	Y	14	110	30
1492	Hexachlorocyclopentadiene	10	ug/L	0.8	ug/L	Y	10	110	30	Y	10	110	30
1497	Hexachloroethane	1	ug/L	0.8	ug/L	Y	12	110	30	Y	10	110	30
1535	Indeno(1,2,3-cd)pyrene	0.2	ug/L	0.1	ug/L	Y	46	121	30	Y	36	116	30
1566	Isophorone	1	ug/L	0.27	ug/L	Y	44	128	30	Y	34	125	30
1829	2-Methylnaphthalene	0.2	ug/L	0.1	ug/L	Y	35	110	30	Y	35	110	30
1851	2-Methylphenol	1	ug/L	0.8	ug/L	Y	30	110	30	Y	26	110	30
1857	4-Methylphenol	1	ug/L	0.8	ug/L	Y	32	110	30	Y	25	110	30
1932	Naphthalene	0.2	ug/L	0.1	ug/L	Y	31	110	30	Y	32	110	30
1960	2-Nitroaniline	2	ug/L	0.8	ug/L	Y	43	130	30	Y	31	129	30
1964	3-Nitroaniline	2	ug/L	0.28	ug/L	Y	45	116	30	Y	23	112	30
1968	4-Nitroaniline	2	ug/L	0.8	ug/L	Y	45	120	30	Y	26	115	30
1972	Nitrobenzene	1	ug/L	0.04	ug/L	Y	37	115	30	Y	26	118	30
1998	2-Nitrophenol	2	ug/L	0.28	ug/L	Y	29	110	30	Y	30	110	30
2001	4-Nitrophenol	5	ug/L	2.4	ug/L	C Y	12	130	30	C Y	13	127	30
2028	N-Nitrosodiphenylamine	1	ug/L	0.31	ug/L	Y	53	113	30	Y	28	118	30
2024	N-Nitrosodi-n-propylamine	1	ug/L	0.8	ug/L	C Y	37	121	30	C Y	25	119	30
3597	2,2'-oxybis(1-Chloropropane)	1	ug/L	0.4	ug/L	Y	25	128					
2118	Pentachlorophenol	5	ug/L	2.4	ug/L	C Y	26	110	30	C Y	23	110	30
2154	Phenanthrene	0.2	ug/L	0.1	ug/L	Y	52	114	30	Y	47	110	30
2155	Phenol	1	ug/L	0.6	ug/L	C Y	14	112	30	C Y	16	110	30
2252	Pyrene	0.2	ug/L	0.1	ug/L	C Y	55	120	30	C Y	54	115	30
##	1,2,4-Trichlorobenzene	1	ug/L	0.24	ug/L	C Y	25	110	30	C Y	25	110	30
2555	2,4,5-Trichlorophenol	5	ug/L	0.3	ug/L	Y	39	110	30	Y	36	110	30
2559	2,4,6-Trichlorophenol	5	ug/L	0.8	ug/L	Y	35	110	30	Y	34	110	30
1425	2-Fluorobiphenyl					X Y	28	110		X Y	28	110	
1426	2-Fluorophenol					X Y	10	110		X Y	10	110	
2512	2,4,6-Tribromophenol					X Y	22	120		X Y	22	120	
2736	Nitrobenzene-d5					X Y	27	111		X Y	27	111	
2737	Phenol-d5					X Y	10	110		X Y	10	110	
2738	Terphenyl-d14					X Y	37	119		X Y	37	119	

CRS SVOC
Matrix: Soil
TCL 4.2 + DCBs and 124-TCB

#	Compound	RL	Units	MDL	Units	T A	Check			T A	Spike		
							LCL	UCL	RPD		LCL	UCL	RPD
1	Acenaphthene	6.67	ug/kg	3.3	ug/kg	C Y	46	110	30	C Y	10	200	30
5	Acenaphthylene	6.67	ug/kg	3.3	ug/kg	Y	47	110	30	Y	10	200	30
24	Acetophenone	100	ug/kg	9.2	ug/kg	Y	50	130	30	Y	50	130	30
122	Anthracene	6.67	ug/kg	3.3	ug/kg	Y	56	111	30	Y	10	200	30
158	Atrazine	200	ug/kg	9.1	ug/kg	Y	50	130	30	Y	50	130	30
3398	Benzaldehyde	100	ug/kg	12	ug/kg	Y	10	130	30	Y	10	130	30
202	Benzo(a)anthracene	6.67	ug/kg	3.3	ug/kg	Y	58	111	30	Y	10	200	30
205	Benzo(b)fluoranthene	6.67	ug/kg	3.3	ug/kg	Y	43	124	30	Y	10	200	30
208	Benzo(k)fluoranthene	6.67	ug/kg	3.3	ug/kg	Y	38	122	30	Y	10	200	30
210	Benzo(ghi)perylene	6.67	ug/kg	3.3	ug/kg	Y	44	120	30	Y	10	200	30
211	Benzo(a)pyrene	6.67	ug/kg	3.3	ug/kg	Y	44	115	30	Y	10	200	30
3474	1,1'-Biphenyl	50	ug/kg	27	ug/kg	Y	50	130	30	Y	50	130	30
289	bis(2-Chloroethoxy)methane	100	ug/kg	22	ug/kg	Y	42	110	30	Y	36	110	30
293	bis(2-Chloroethyl) ether	100	ug/kg	2	ug/kg	Y	41	110	30	Y	32	118	30
302	bis(2-Ethylhexyl) phthalate	50	ug/kg	19	ug/kg	Y	56	123	30	Y	10	200	30
348	4-Bromophenyl phenyl ether	50	ug/kg	13	ug/kg	Y	53	112	30	Y	44	120	30
403	Butyl benzyl phthalate	50	ug/kg	10	ug/kg	Y	57	121	30	Y	43	138	30
5101	Caprolactam	330	ug/kg	37	ug/kg	Y	50	130	30	Y	50	130	30
2751	Carbazole	50	ug/kg	27	ug/kg	Y	56	115	30	Y	10	162	30
518	4-Chloroaniline	150	ug/kg	17	ug/kg	Y	25	110	30	Y	11	110	30
578	4-Chloro-3-methylphenol	150	ug/kg	21	ug/kg	C Y	42	110	30	C Y	32	117	30
589	2-Chloronaphthalene	50	ug/kg	3.3	ug/kg	Y	46	110	30	Y	40	110	30
600	2-Chlorophenol	50	ug/kg	27	ug/kg	C Y	39	110	30	C Y	32	110	30
602	4-Chlorophenyl phenyl ether	50	ug/kg	13	ug/kg	Y	53	110	30	Y	47	116	30
633	Chrysene	6.67	ug/kg	1.1	ug/kg	Y	56	111	30	Y	10	200	30
860	Dibenz(a,h)anthracene	6.67	ug/kg	3.3	ug/kg	Y	45	122	30	Y	10	200	30
863	Dibenzofuran	50	ug/kg	3.3	ug/kg	Y	50	110	30	Y	10	200	30
891	Di-n-butyl phthalate	50	ug/kg	15	ug/kg	Y	57	119	30	Y	31	145	30
918	3,3'-Dichlorobenzidine	100	ug/kg	18	ug/kg	Y	31	110	30	Y	10	110	30
##	1,2-Dichlorobenzene	50	ug/kg	9.7	ug/kg	Y	42	110	30	Y	29	110	30
907	1,3-Dichlorobenzene	50	ug/kg	11	ug/kg	Y	40	110	30	Y	29	110	30
910	1,4-Dichlorobenzene	50	ug/kg	20	ug/kg	C Y	38	110	30	C Y	26	110	30
971	2,4-Dichlorophenol	150	ug/kg	20	ug/kg	Y	40	110	30	Y	33	110	30
1082	Diethyl phthalate	50	ug/kg	16	ug/kg	Y	55	114	30	Y	48	118	30
1145	2,4-Dimethylphenol	150	ug/kg	20	ug/kg	Y	28	110	30	Y	19	114	30
1149	Dimethyl phthalate	50	ug/kg	17	ug/kg	Y	54	112	30	Y	47	116	30
1167	4,6-Dinitro-2-methylphenol	150	ug/kg	80	ug/kg	Y	21	110	30	Y	10	110	30
1187	2,4-Dinitrophenol	330	ug/kg	80	ug/kg	Y	10	110	30	Y	10	110	30
1191	2,4-Dinitrotoluene	200	ug/kg	27	ug/kg	C Y	55	116	30	C Y	42	118	30
1193	2,6-Dinitrotoluene	200	ug/kg	21	ug/kg	Y	54	115	30	Y	28	137	30
1162	Di-n-octyl phthalate	50	ug/kg	27	ug/kg	Y	45	123	30	Y	10	182	30
1414	Fluoranthene	6.67	ug/kg	3.3	ug/kg	Y	55	118	30	Y	10	200	30
1417	Fluorene	6.67	ug/kg	3.3	ug/kg	Y	51	110	30	Y	10	187	30
1482	Hexachlorobenzene	6.67	ug/kg	2.1	ug/kg	Y	51	110	30	Y	37	122	30
1489	Hexachlorobutadiene	50	ug/kg	27	ug/kg	Y	39	110	30	Y	30	110	30
1492	Hexachlorocyclopentadiene	330	ug/kg	27	ug/kg	Y	10	110	30	Y	10	110	30
1497	Hexachloroethane	50	ug/kg	9	ug/kg	Y	38	110	30	Y	13	110	30
1535	Indeno(1,2,3-cd)pyrene	6.67	ug/kg	3.3	ug/kg	Y	45	121	30	Y	10	200	30
1566	Isophorone	50	ug/kg	13	ug/kg	Y	46	117	30	Y	32	129	30
1829	2-Methylnaphthalene	6.67	ug/kg	3.3	ug/kg	Y	46	110	30	Y	10	200	30
1851	2-Methylphenol	200	ug/kg	80	ug/kg	Y	36	110	30	Y	19	124	30
1857	4-Methylphenol	200	ug/kg	80	ug/kg	Y	40	110	30	Y	27	116	30
1932	Naphthalene	6.67	ug/kg	3.3	ug/kg	Y	42	110	30	Y	10	200	30
1960	2-Nitroaniline	200	ug/kg	9.1	ug/kg	Y	47	124	30	Y	31	141	30
1964	3-Nitroaniline	200	ug/kg	16	ug/kg	Y	44	110	30	Y	24	110	30
1968	4-Nitroaniline	200	ug/kg	26	ug/kg	Y	50	110	30	Y	23	124	30
1972	Nitrobenzene	100	ug/kg	2.2	ug/kg	Y	40	110	30	Y	33	111	30
1998	2-Nitrophenol	50	ug/kg	27	ug/kg	Y	35	110	30	Y	17	110	30
2001	4-Nitrophenol	330	ug/kg	80	ug/kg	C Y	24	117	30	C Y	10	125	30
2028	N-Nitrosodiphenylamine	50	ug/kg	21	ug/kg	Y	54	112	30	Y	10	169	30
2024	N-Nitrosodi-n-propylamine	50	ug/kg	27	ug/kg	C Y	40	114	30	C Y	30	121	30
3597	2,2'-oxybis(1-Chloropropane)	100	ug/kg	9.5	ug/kg	Y	36	116	30				
2118	Pentachlorophenol	150	ug/kg	80	ug/kg	C Y	10	110	30	C Y	10	182	30
2154	Phenanthrene	6.67	ug/kg	3.3	ug/kg	Y	54	110	30	Y	10	200	30
2155	Phenol	50	ug/kg	27	ug/kg	C Y	39	110	30	C Y	10	144	30
2252	Pyrene	6.67	ug/kg	3.3	ug/kg	C Y	58	113	30	C Y	10	200	30
##	1,2,4-Trichlorobenzene	50	ug/kg	27	ug/kg	C Y	43	110	30	C Y	33	110	30
2555	2,4,5-Trichlorophenol	150	ug/kg	25	ug/kg	Y	42	110	30	Y	32	112	30
2559	2,4,6-Trichlorophenol	150	ug/kg	80	ug/kg	Y	37	110	30	Y	22	110	30
1425	2-Fluorobiphenyl					X Y	34	110		X Y	34	110	
1426	2-Fluorophenol					X Y	26	110		X Y	26	110	
2512	2,4,6-Tribromophenol					X Y	10	118		X Y	10	118	
2736	Nitrobenzene-d5					X Y	24	112		X Y	24	112	
2737	Phenol-d5					X Y	28	110		X Y	28	110	
2738	Terphenyl-d14					X Y	41	119		X Y	41	119	

CRS Metals List

Matrix: Soil

Method: SW846 6010B

#	Compound	RL	Units	MDL	Units	T	A	Check			T	A	Spike		
								LCL	UCL	RPD			LCL	UCL	RPD
128	Antimony	1	mg/kg	0.39	mg/kg	Y		80	120	20	Y		75	125	20
140	Arsenic	1	mg/kg	0.3	mg/kg	Y		80	120	20	Y		75	125	20
1605	Lead	0.3	mg/kg	0.19	mg/kg	Y		80	120	20	Y		75	125	20
1539	Iron	10	mg/kg	4.9	mg/kg	Y		73	137	20	Y		75	125	20

Matrix: Water

Method: SW846 6010B

#	Compound	RL	Units	MDL	Units	T	A	Check			T	A	Spike		
								LCL	UCL	RPD			LCL	UCL	RPD
128	Antimony	6	ug/L	1.8	ug/L	Y		80	120	20	Y		75	125	20
140	Arsenic	10	ug/L	3.2	ug/L	Y		80	120	20	Y		75	125	20
411	Cadmium	2	ug/L	0.66	ug/L	Y		80	120	20	Y		75	125	20
1605	Lead	3	ug/L	1.9	ug/L	Y		80	120	20	Y		75	125	20
1539	Iron	100	ug/L	81	ug/L	Y		80	120	20	Y		75	125	20
1659	Manganese	15	ug/L	0.41	ug/L	Y		80	120	20	Y		75	125	20

PCBs - CRS
Matrix: Water

Method: SW846 8082							Check			Spike			
#	Compound	RL	Units	MDL	Units	T A	LCL	UCL	RPD	T A	LCL	UCL	RPD
2082	Aroclor 1016	33	ug/kg	16	ug/kg	C Y	34	127	30	C Y	10	199	30
2085	Aroclor 1221	33	ug/kg	16	ug/kg								
2088	Aroclor 1232	33	ug/kg	14	ug/kg								
2091	Aroclor 1242	33	ug/kg	13	ug/kg								
2094	Aroclor 1248	33	ug/kg	17	ug/kg								
2097	Aroclor 1254	33	ug/kg	17	ug/kg								
2100	Aroclor 1260	33	ug/kg	17	ug/kg	C Y	32	141	30	C Y	10	199	30
2732	Decachlorobiphenyl					X Y	10	199		X Y	10	199	
2739	Tetrachloro-m-xylene					X Y	10	196		X Y	10	196	

Matrix: Soil

Method: SW846 8082							Check			Spike			
#	Compound	RL	Units	MDL	Units	T A	LCL	UCL	RPD	T A	LCL	UCL	RPD
2082	Aroclor 1016	0.5	ug/L	0.17	ug/L	C Y	44	119	30	C Y	10	166	30
2085	Aroclor 1221	0.5	ug/L	0.13	ug/L								
2088	Aroclor 1232	0.5	ug/L	0.16	ug/L								
2091	Aroclor 1242	0.5	ug/L	0.22	ug/L								
2094	Aroclor 1248	0.5	ug/L	0.1	ug/L								
2097	Aroclor 1254	0.5	ug/L	0.16	ug/L								
2100	Aroclor 1260	0.5	ug/L	0.17	ug/L	C Y	41	118	30	C Y	21	140	30
2732	Decachlorobiphenyl					X Y	10	127		X Y	10	127	
2739	Tetrachloro-m-xylene					X Y	27	130		X Y	27	130	

Appendix C: Health and Safety Plan (HASP)

CDROM

Health and Safety Plan for Sampling, Monitor Well Installation, and CQA Activities

142 Locust Street
Elyria, Ohio

November 9, 2010

BC Project Number: 139452

Prepared by:

B R O W N A N D C A L D W E L L

4700 Lakehurst Court, Suite 100
Columbus, Ohio 43056

Prepared for:

CRS Site Settling Performing Parties

Approval Page

This Health and Safety Plan (HASP) has been prepared and reviewed by the following Brown and Caldwell (BC) personnel for use at the Chemical Recovery Solvents, Inc. site (139452).

	Name	Signature	Title	Date
<i>Prepared By:</i>	Bryant Kiedrowski		Health and Safety Coordinator	11/9/10
<i>Reviewed By:</i>	Jim Krebs		Site Safety Officer	
<i>Reviewed By:</i>	Jim Peebles		Project Manager	11/9/10
<i>Reviewed By:</i>	Doug Rosco, CSP		Regional Safety Unit Manager	
<i>Effective Dates:</i>	November 9, 2010 through November 8, 2011			

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APPENDIX A A

 Air Monitoring Form A

LIST OF APPENDICES

Appendix A Air Monitoring Form

Appendix B Site Safety Checklist

Appendix C H&S Plan Acknowledgement Form

Appendix D Daily Tailgate Meeting Form

Appendix E Incident Investigation Form

Appendix F Miscellaneous Health and Safety Information

CRITICAL PROJECT INFORMATION

Primary Known Compounds of Concern: 1,1,1-TCA; 1,1-DCA; 1,1-DCE; Methylene Chloride; TCE; cis-1, 2 DCE; Benzene; Toluene; Ethylbenzene; Xylene; Syrene; PCBs

Minimum Level of Respiratory Protection: None anticipated, [unless action limits are met](#)

PPE: Level D (Hard Hat, Safety Glasses, Safety Boots); high visibility vest (if working around mobile equipment); nitrile gloves for any sample collection, **leather gloves (when opening acetate liners or using hand tools)**.

SEE SECTION 10 FOR SITE EMERGENCY CONTINGENCY PROCEDURES

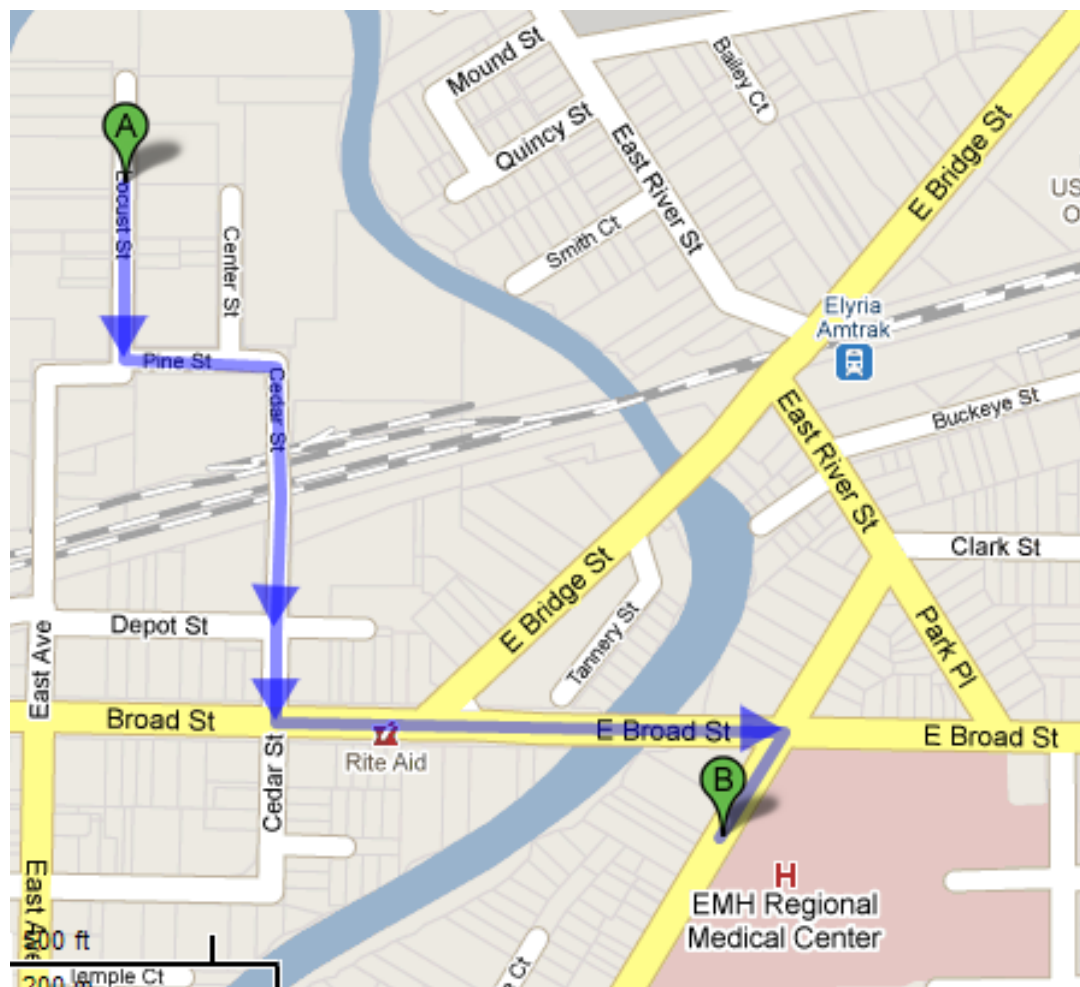
Do not endanger your own life. Survey the situation before taking any action.

BC Office Telephone	614-410-6144
Site Location Address	4700 Lakehurst Court, Suite 100 Columbus, Ohio

EMERGENCY PHONE NUMBERS: In the event of emergency, contact the Project Manager and/or Regional Safety Unit Manager.

Emergency Services (Ambulance, Fire, Police)	911
Poison Control	(800) 876-4766 or (800) 222-1222
Hospital Name	Elyria Memorial Hospital
Hospital Phone Number	440-329-7500
BC Project Manager (PM; Jim Peeples)	Office: 614-410-3081 Cell: 614-288-7201
BC Site Safety Officer (SSO; Scott Blanchard)	Office: 614-923-0848 Cell: 614-361-5849
BC Site Safety Officer (SSO; Jim Krebs)	Office: 614-923-0853 Cell: 614-653-5474
BC Regional Safety Unit Manager (Doug Rosco)	Office: (303) 659-5930 Cell: (303) 994-9675
Corporate Risk Management	Property Loss Blythe Buetzow: (925) 210-2470 Injury Angela Hernandez: (925) 210-2218
Client Contact (Patrick Steerman)	Office: 770-992-2836 Cell: 404-421-3275

HOSPITAL LOCATION MAP



HOSPITAL DIRECTIONS:

1. South on Locust St toward Pine St (430 ft)
2. 1st left onto Pine St (0.2 mi)
3. Continue onto Cedar St (233 ft)
4. Left at Broad St (0.2 mi)
5. 1st right onto E River St (299 ft)
6. Hospital on left

HOSPITAL INFORMATION:

Elyria Memorial Hospital
630 E River St
Elyria, OH 44035

Phone: 440-329-7500

EMERGENCY FIRST AID PROCEDURES

THE RESPONDER SHOULD HAVE APPROPRIATE TRAINING TO ADMINISTER FIRST AID OR CPR

1. Survey the situation. Do not endanger your own life. **DO NOT ENTER A CONFINED SPACE TO RESCUE SOMEONE WHO HAS BEEN OVERCOME.** ENSURE ALL PROTOCOLS ARE FOLLOWED INCLUDING THAT A STANDBY PERSON IS PRESENT. IF APPLICABLE, REVIEW MSDSs TO EVALUATE RESPONSE ACTIONS FOR CHEMICAL EXPOSURES.
2. Call 911 (if available) or the fire department **IMMEDIATELY.** Explain the physical injury, chemical exposure, fire, or release.
3. Decontaminate the victim if it can be done without delaying life-saving procedures or causing further injury to the victim.
4. If the victim's condition appears to be non-critical, but seems to be more severe than minor cuts, he/she should be transported to the nearest hospital by the SSO or designated personnel: let the doctor assume the responsibility for determining the severity and extent of the injury. If the condition is obviously serious, contact emergency medical services (EMS) for transport or appropriate actions.

Notify the PM and Regional Safety Unit Manager immediately and complete the appropriate incident investigation reports as soon as possible.

STOP BLEEDING AND CPR GUIDELINES	
To Stop Bleeding	CPR
<ol style="list-style-type: none"> 1. Give medical statement by indicating you are trained in 1st Aid. 2. Assure: airway, breathing and circulation. 3. Use DIRECT PRESSURE over the wound with clean dressing or your hand (use non-permeable gloves). Direct pressure will control most bleeding. 4. Bleeding from an artery or several injury sites may require DIRECT PRESSURE on a PRESSURE POINT. Use pressure points for 30 -60 seconds to help control severe bleeding. 5. Continue primary care and seek medical aid as needed. 	<ol style="list-style-type: none"> 1. Give medical statement by indicating you are trained in CPR. 2. Arousal: Check for consciousness. 3. Call out for help, either call 911 yourself or instruct someone else to do so. It is very important to call for emergency assistance prior to initiating CPR. 4. Open airway with chin-lift. 5. Look, listen and feel for breathing. 6. If breathing is absent, give 2 slow, full rescue breaths. 7. Look, listen and feel for breathing. 8. If breathing is absent, initiate CPR; 30 compressions for each two breaths. 9. If an automated external defibrillator (AED) is available, use it in accordance with the AED instructions.

HEALTH AND SAFETY PLAN

1. INTRODUCTION

Brown and Caldwell (BC) has prepared this Health and Safety Plan (HASP) for use during the sampling, monitor well installation, demolition and CQA activities to be conducted at the CRS site located at 142 Locust Street, Elyria, Ohio (“the Site”). Activities conducted under BC’s direction at the Site will be in compliance with applicable Occupational Safety and Health Administration (OSHA) regulations, particularly those in Title 29 of the Code of Federal Regulations, Part 1910.120 (29 CFR 1910.120), and other applicable federal, state, and local laws, regulations, and statutes. A copy of this HASP will be kept on site during scheduled field activities.

This HASP addresses the identified hazards associated with planned field activities at the Site. It presents the minimum health and safety requirements for establishing and maintaining a safe working environment during the course of work. In the event of conflicting requirements, the procedures or practices that provide the highest degree of personnel protection will be implemented. If scheduled activities change or if site conditions encountered during the course of the work are found to differ substantially from those anticipated, the Regional Safety Unit Manager and Project Manager will be informed immediately upon discovery, and appropriate changes will be made to this HASP.

BC’s health and safety programs and procedures, including medical monitoring, respiratory protection, injury and illness prevention, hazard communication, and personal protective equipment (PPE), are documented in the BC Health & Safety Manual. The Health & Safety Manual is readily accessible to BC employees via the BC Pipeline. These health and safety procedures are incorporated herein by reference, and BC employees will adhere to the procedures specified in the manual.

BC’s HASP has been prepared specifically for this project and is intended to address health and safety issues solely with respect to the activities of BC’s own employees at the site. A copy of BC’s HASP may be provided to subcontractors in an effort to help them identify expected conditions at the site and general site hazards. The subcontractor shall remain responsible for identifying and evaluating hazards at the site as they pertain to their activities and for taking appropriate precautions. For example, BC’s HASP does not address specific hazards associated with tasks and equipment that are particular to the subcontractor’s scope of work and site activities (e.g., operation of a drill rig, excavator, crane or other equipment). Subcontractors are not to rely on BC’s HASP to identify all hazards that may be present at the Site.

Subcontractors are responsible for developing, maintaining, and implementing their own health and safety programs, policies, procedures and equipment as necessary to protect their workers, and others, from their activities. Subcontractors shall operate equipment in accordance with their standard operating procedures as well as manufacturer’s specifications. Any project monitoring activities conducted by BC at the Site shall not in any way relieve subcontractors of their critical obligation to monitor their operations and employees for the determination of exposure to hazards that may be present at the Site and to provide required guidance and protection. If requested,

subcontractors will provide BC with a copy of their own HASP for this project or other health and safety program documents for review.

1.1 Site History

The Site has been in industrial use since the later 1800's. In 1960, Russell Obitts began operations by leasing lots from the Swiers Coal Company. On March 23, 1965, Dorothy K. Dubena purchased the parcels from the Swiers Coal Company. Dorothy Dubena married Russell Obitts and became Dorothy Obitts. Beginning no later than the 1940s the CRS Site was used for commercial and industrial purposes such as a coal yard. Two companies were owned by Mr. Obitts and operated at this Site from 1960 through 1974. Obitts Chemical Services operated a solvent reclamation facility. Obitts Chemical Company sold the reclaimed solvents to industry. Obitts obtained used, "scrap" or "spent" organic solvents from various companies. After distilling the "dirty" solvents, the "cleaned" reclaimed solvents were repackaged and sold. The solvents were transported to and from the Site in 55-gallon drums or by tanker trucks.

From 1974 to 1981, CRS continued in the business of solvent reclamation and sales. The solvents continued to be stored in 55-gallon drums, ASTs, and tanker trucks. It is alleged that several spills and releases occurred during this time. In 1980, the USEPA filed a lawsuit against CRS, requiring the facility owners to abate environmental issues identified at the Site. In response to this lawsuit, CRS ceased the receipt, processing, and storage of spent solvents and removed tanks, drums, and other solvent containers from the Site in 1981. CRS ceased operations and filed for bankruptcy prior to 1983.

1.2 Site Description

The Site is located at 142 Locust Street (formerly Maple Street) in Elyria, Lorain County, Ohio and is located in a predominantly industrial area of Elyria, Ohio. The western boundary of the Site runs along the East Branch of the Black River (River). To the north and east, the Site is bordered by the BASF Corporation (formerly Engelhard Corporation and prior to that the Harshaw Chemical Company). Locust Street runs along the eastern boundary of the CRS Site. The M&M Aluminum Siding property to the south was recently acquired by BASF for an expansion project.

Two buildings (located on the southeast corner of the Site) remain on the property. One building is the former warehouse and office building and the other is a portion of the Rodney Hunt Still Building. These buildings have historically been leased and utilized for storage of carpeting and other miscellaneous items by M&M Improvement Company. A concrete slab foundation of a former building is located in the northwest corner of the property. In addition, a concrete slab foundation for the Brighton Still building, and the secondary containment dike for a former AST farm remain in the northwestern corner of the Site (all tanks have been removed from the AST farm). Two sumps remain onsite, one sump is located in the Rodney Hunt Building and the other, is located in the former Brighton Still Building. Four pipes (subsurface conduits) are located along the western boundary of the property along the River. The primary subsurface conduit is a storm sewer pipe that runs from Locust Street under the Site to the River. A manhole on Locust Street provides access to the storm sewer, which drains run-off from BASF and other commercial and industrial sites comprising approximately one fourth of the downtown Elyria area. Cars, trucks, wood waste, and other debris are also located on the property.

The working area of the Site is essentially level and consists of a grassy cover with patches of gravel and asphalt. Surface drainage is westward, towards the East Branch of the Black River (the River). The western edge of the Site is heavily vegetated with a steep grade from the working area to the East Bank of the Black River. The property is fenced on the northern, eastern, and southern sides, restricting casual access to the Site.

1.3 Scope of Work

Work on-site will include:

- Well installation in unconsolidated aquifers
- Well installation in bedrock aquifers
- Monitoring well abandonment
- Monitored natural attenuation (groundwater sampling)
- CQA activities of work performed by subcontractors (i.e. driller, asbestos abatement, etc.) on-site
-

HEALTH AND SAFETY PLAN

2. KEY BC PROJECT PERSONNEL AND RESPONSIBILITIES

Jim Peebles is the Project Manager (PM). Doug Rosco is the Regional Safety Unit Manager (RSUM). Scott Blanchard and Jim Krebs have been designated as BC Site Safety Officers (SSO) for this project. The BC project field staff have completed 40 hours of comprehensive health and safety training, which meets the requirements of 29 CFR 1910.120.

The responsibilities of key BC project personnel are presented below.

2.1 Project Manager

The PM is responsible for evaluating hazards anticipated at the Site and working with designated field staff and the RSUM to prepare this HASP to address the identified hazards. The PM is also responsible for the following.

- Informing project participants of safety and health hazards identified at the Site.
- Providing a copy of this HASP to BC project participants and a copy to each BC subcontractor prior to the start of field activities.
- Ensuring that the BC project team is adequately trained and perform safety briefings in accordance with this HASP.
- Providing the resources necessary for maintaining a safe and healthy work environment for BC personnel.
- Communicating project safety concerns to the RSUM for determining corrective actions.

2.2 Site Safety Officer

The SSO has on-Site responsibility for verifying that BC team members, including subcontractors, comply with the provisions of this HASP. The SSO has the authority to monitor and correct health and safety issues as noted on-Site. The SSO is responsible for the following.

- Reporting unforeseen or unsafe conditions or work practices at the Site to the PM or RSUM.
- Stopping operations that threaten the health and safety of BC field team or members of the surrounding community.
- Monitoring the safety performance of Site personnel to evaluate the effectiveness of health and safety procedures.
- Performing air monitoring, as necessary, as prescribed in this HASP.
- Documenting field team compliance with this HASP by completing the appropriate BC forms contained in the Appendices of this document.
- Conducting daily tailgate safety meetings and assuring that project personnel understand the requirements of this HASP (as documented by each BC field team member's signature on the Signature Page).

- Limiting access to BC work areas on the Site to BC field team members and authorized personnel.
- Enforcing the “buddy system” as appropriate for Site activities.
- Performing periodic inspections to evaluate safety practices at the Site.
- Identifying the location and route to nearby medical facility and emergency contact information and coordinating appropriate responses in the event of emergency.

2.3 Regional Safety Unit Manager

The RSUM is responsible for final review and modification of this HASP. Modifications to this HASP that result in less protective measures than those specified may not be employed by the PM or SSO without the approval of the RSUM. In addition, the RSUM has the following responsibilities.

- Developing and coordinating the overall BC health and safety program.
- Advising the PM and SSO on matters relating to health and safety on this project.
- Recommending appropriate safeguards and procedures.
- Modifying this HASP, if necessary, and approving changes in health and safety procedures at the Site.

2.4 BC Team Members

BC employees and subcontractors are responsible for familiarizing themselves with health and safety aspects of the project and for conducting their activities in a safe manner. This includes attending site briefings, communicating health and safety observations and concerns to the SSO, maintaining current medical and training status and maintaining and using proper tools, equipment and PPE. Proper work practices are part of ensuring a safe and healthful working environment. Safe work practices are essential and it is the responsibility of BC employees and team members to follow safe work practices when conducting scheduled activities. Safe work practices to be employed during the entire duration of fieldwork include, but are not limited to, the following.

- Following the provisions of this HASP, company health and safety procedures and regulatory requirements.
- Reviewing safety-related information from other parties (i.e., client or contractors) as it relates to BC’s activities.
- Inspecting personal protective equipment (PPE) before on-site use, using only intact protective clothing and related gear, and changing suits, gloves, etc. if they are damaged or beyond their useful service life.
- Set up, assemble, and check out all equipment and tools for integrity and proper function before starting work activities.
- Assisting in and evaluating the effectiveness of Site procedures (including decontamination) for personnel, protective equipment, sampling equipment and containers, and heavy equipment and vehicles.
- Practice the “buddy system” as appropriate for site activities.

- Do not use faulty or suspect equipment.
- Do not use hands to wipe sweat away from face. Use a clean towel or paper towels.
- Practice contamination avoidance whenever possible.
- Do not smoke, eat, drink, or apply cosmetics while in chemically-affected areas of the site or before proper decontamination.
- Wash hands, face and arms before taking rest and lunch breaks and before leaving the site and the end of the workday.
- Check in and out with the SSO upon arrival and departure from the site.
- Perform decontamination procedures as specified in this HASP.
- Notify the SSO immediately if there is an incident that causes an injury, illness or property loss. Incidents that could have resulted in injury, illness or property loss (close call) will also be reported to the SSO.
- Do not approach or enter an area where a hazardous environment (i.e., oxygen deficiency, toxic or explosive) may exist without employing necessary engineering controls, proper PPE and appropriate support personnel.
- Use respirators correctly and as required for the Site; check the fit of the respirator with a negative or positive pressure test; do not wear respirator with facial hair or other conditions that prevent a face-to-facepiece seal.
- Confined spaces will not be entered without appropriate evaluation, equipment, training and support personnel.

2.5 Subcontractors

Subcontractor personnel are expected to comply fully with subcontractor's HASP and to observe the minimum safety guidelines applicable to their activities which may be identified in the BC HASP. Failure to do so may result in the removal of the subcontractor or any of the subcontractor's workers from the job site.

HEALTH AND SAFETY PLAN

3. HAZARD ANALYSIS

Hazards at the Site may include physical hazards, chemical hazards or biological hazards. Each type of identified hazard is addressed in the following sections. Hazards that are the specialty of a subcontractor (i.e., operation of a drill rig or excavator) are not addressed in this HASP. Subcontractors are responsible for identifying potential hazards associated with their activities and implementing proper controls.

3.1 Chemical Hazards

Exposure pathways of concern for chemical compounds that may be present at the Site are inhalation of airborne contaminants, direct skin contact with contaminated materials, and incidental ingestion of affected media. Wearing protective equipment and following decontamination procedures listed in Section 7 can minimize dermal contact and incidental ingestion. To minimize inhalation hazards, dust or vapor control measures will be implemented, where necessary, and action levels will be observed during scheduled activities. Site-specific action levels and air monitoring requirements are presented in Section 5.

Known or Suspected Compounds	Source (soil/water/sludge, etc.)	Known Concentration Range (mg/l)
1,1,1-TCA	groundwater	23
1,1-DCA	groundwater	4.0
1,1-DCE	groundwater	1.8
Methylene Chloride	groundwater	33
TCE	groundwater	20
1,2 DCE (cis)	groundwater	76
Benzene	groundwater	2.3
Toluene	groundwater	20
Ethylbenzene	groundwater	0.87
Xylenes	groundwater	3.1
Styrene	groundwater	1.6
PCBs	soil	70

Chemical descriptions of chemicals of concern, including health effects and exposure limits, are presented in the following paragraphs. Each chemical description includes physical and odor recognition characteristics, the health effects associated with exposure, and exposure limits expressed as an 8-hour time-weighted average (TWA). Provided are federal OSHA (OSHA) permissible exposure limits (PELs; located in 29 CFR 1910.1000); California OSHA (Cal/OSHA) PELs (located in 8 CCR 5155); and the American Conference of Governmental Industrial

Hygienists (ACGIH) threshold limit values (TLVs). For sites outside California, Cal/OSHA PELs are included as an additional reference.

1,1,1-TRICHLOROETHANE (1,1,1-TCA)

1,1,1-TCA (also known as methyl chloroform) is a colorless liquid with a mild odor, like chloroform. It is moderately toxic by inhalation and skin contact. It is a skin irritant and can cause central nervous system effects such as hallucinations or distorted perceptions, motor activity changes, irritability, and aggression. Gastrointestinal changes such as diarrhea, nausea, or vomiting have also been reported from 1,1,1-TCA exposure at high concentrations. Short-term exposure to 1,1,1-TCA vapor may cause headaches, dizziness, drowsiness, unconsciousness, irregular heart beat, and death. 1,1,1-TCA liquid splashed in the eye causes irritation.

Prolonged inhalation at high concentrations may affect the central nervous system and, if massively inhaled, may cause cardiac arrest. Exposure to vapors may cause mild eye irritation, and prolonged skin contact may produce irritation and dermatitis. Brief exposure to high concentrations of vapor may cause a slight loss of coordination because of its anesthetic properties.

- The OSHA PEL is listed as 350 ppm.
- The Cal/OSHA PEL is listed as 350 ppm.
- The TLV is listed as 350 ppm.

1,1-DICHLOROETHANE (1,1-DCA)

1,1-DCA is a colorless liquid with a chloroform-like odor. It is moderately toxic by ingestion and is an experimental tumorigen and teratogen as well as a suspected human carcinogen. Short-term inhalation exposure to 1,1-DCA vapor may cause drowsiness and unconsciousness. It might also cause damage to the liver, kidneys, and lungs. Splashing the liquid in the eyes may cause irritation. 1,1-DCA is classified by the U.S. Environmental Protection Agency as a Group B2 probable human carcinogen.

- The OSHA PEL is listed as 100 ppm.
- The Cal/OSHA PEL is listed as 100 ppm.
- The TLV is listed as 100 ppm.

1,1-DICHLOROETHYLENE (1,1-DCE)

1,1-DCE (also known as vinylidene chloride) is a volatile, colorless liquid that polymerizes easily and has a mild, sweet odor. Short-term exposure to 1,1-DCE can cause irritation to the skin and mucous membranes. 1,1-DCE is narcotic in high concentrations and can cause

liver and kidney damage. 1,1-DCE has been identified by the National Institute for Occupational Safety and Health as a carcinogen.

- An OSHA PEL is not listed.
- The Cal/OSHA PEL is listed as 1 ppm.
- The TLV is listed as 5 ppm

1,2-DICHLOROETHENE (1,2-DCE)

1,2-Dichloroethylene (1,2-DCE), a mixture of the cis and trans isomers, is a liquid with a slightly acrid odor. Available data conflict on whether there is significant difference in the toxicity from short-term exposure to trans-1,2-DCE versus cis-1,2-DCE. Narcosis has been identified as the important effect of inhalation.

- The OSHA PEL is listed as 200 ppm.
- The Cal/OSHA PEL is listed as 200 ppm.
- The TLV is listed as 200 ppm.

METHYL CHLORIDE

Methyl chloride (also known as chloromethane) is a colorless gas with an ethereal odor and sweet taste. It is a suspected carcinogen that displays experimental reproductive effects and is mildly toxic by inhalation. Human systemic effects by inhalation include convulsions, nausea or vomiting, and effects on the eye. Methyl chloride has slight irritant properties and may be inhaled without noticeable discomfort. In exposures to high concentrations, dizziness, drowsiness, loss of coordination, confusion, nausea and vomiting abdominal pains and dimness of vision are followed by delirium, convulsions and coma. If sprayed on the skin, methyl chloride produces anesthesia through freezing of the tissues as it evaporates.

It is a flammable gas and is very dangerous fire hazard when exposed to heat, flame or powerful oxidizers. When heated to decomposition, it emits toxic fumes of Cl₂.

- The OSHA PEL is listed as 100 ppm.
- The Cal/OSHA PEL is listed as 5 ppm.
- The TLV is listed as 50 ppm.

Note: Published exposure limits designate a skin notation indicating that dermal contact can contribute to the overall exposure.

TRICHLOROETHYLENE (TCE)

TCE is a clear, colorless liquid with a characteristic chloroform odor. It is a mildly toxic VOC that is also an experimental carcinogen, tumorigen, and teratogen. It can cause eye

effects, hallucinations and distorted perceptions when inhaled. TCE is an eye and severe skin irritant. Exposure to vapors may cause eye, nose and throat irritation. Prolonged inhalation of moderate concentrations of vapor may cause headaches and drowsiness. Inhalation of high concentrations may cause narcosis and anesthesia. Severe, acute exposure can result in cardiac failure. Significant chronic exposure may damage the liver and other organs. Prolonged repeated skin contact with the liquid may cause irritation and dermatitis.

- The OSHA PEL is listed as 100 ppm.
- The Cal/OSHA PEL is listed as 25 ppm.
- The TLV is listed as 10 ppm.

BENZENE

Benzene is a clear, volatile liquid. It is colorless, highly flammable, and toxic, with a characteristic odor. It is a severe eye and moderate skin irritant. Human effects by inhalation and ingestion include euphoria, changes in sleep and motor activity, nausea and vomiting, other blood effects, dermatitis, and fever. In industry, inhalation is the primary route of chronic benzene poisoning. If the liquid is aspirated into the lung it may cause pulmonary edema. Poisoning by skin contact has also been reported. Exposure to high concentrations (3,000 ppm) may result in acute poisoning, which is characterized by the narcotic action of benzene on the central nervous system. Chronic poisoning occurs most commonly through inhalation and dermal absorption. Benzene is a known human carcinogen that can cause leukemia.

- The OSHA PEL is listed as 1 ppm.
- The Cal/OSHA PEL is listed as 1 ppm.
- The TLV is listed as 0.5 ppm.

Note: Published exposure limits designate a skin notation indicating that dermal contact can contribute to the overall exposure.

TOLUENE

Toluene is a colorless liquid with a benzol-like odor. Human systemic effects of exposure to toluene include central nervous system changes, hallucinations or distorted perceptions, motor activity changes, psychophysiological changes, and bone marrow changes. It is a severe eye irritant and an experimental teratogen. Inhalation of high vapor concentrations may cause impairment of coordination and reaction time, headaches, nausea, eye irritation, loss of appetite, a bad taste in the mouth, and lassitude.

- The OSHA PEL is listed as 200 ppm.
- The Cal/OSHA PEL is listed as 50 ppm.
- The TLV is listed as 20 ppm.

Note: Published exposure limits designate a skin notation indicating that dermal contact can contribute to the overall exposure.

ETHYLBENZENE

Ethylbenzene is a clear, colorless liquid. It is mildly toxic by inhalation and skin contact. Inhalation can cause eye, sleep, and pulmonary changes. It is an eye and skin irritant at levels as low as 0.1% (1,000 ppm) of the vapor in air. At higher concentrations, it is extremely irritating at first, then can cause dizziness, irritation of the nose and throat, and a sense of constriction in the chest. Exposure to high concentrations of ethylbenzene vapor may result in irritation of the skin and mucous membranes, dizziness, irritation of the nose and throat, and a sense of constriction of the chest.

- The OSHA PEL is listed as 100 ppm.
- The Cal/OSHA PEL is listed as 100 ppm.
- The TLV is listed as 100 ppm.

XYLENE

Xylene is a clear, colorless liquid. It exhibits the general chlorinated hydrocarbon central nervous system effects, olfactory (smell) changes, eye irritation and pulmonary changes. It is a severe skin irritant. There are three isomers: ortho, meta, and para. Exposure to high concentrations of xylene vapor may result in eye and skin irritation. Eye irritation may occur at concentrations of about 200 ppm.

- The OSHA PEL is listed as 100 ppm.
- The Cal/OSHA PEL is listed as 100 ppm.
- The TLV is listed as 100 ppm.

STYRENE

Styrene is a colorless liquid with a sweet, aromatic odor at low concentrations, and a sharp, penetrating, disagreeable odor at higher levels. It is a suspected human carcinogen and a skin and eye irritant. Styrene is a dangerous fire hazard. It is explosive in the vapor form.

- The OSHA PEL is listed as 100 ppm.
- The Cal/OSHA PEL is listed as 50 ppm.
- The TLV is listed as 20 ppm.

Note: Published exposure limits designate a skin notation indicating that dermal contact can contribute to the overall exposure.

POLYCHLORINATED BIPHENYLS (PCBs)

PCBs are a series of technical mixtures consisting of many isomers and compounds that vary from mobile oil liquids to white crystalline solids and hard non-crystalline resins. Technical products vary in composition, in the degree of chlorination, and possibly according to batch. Generally, they are moderately toxic by ingestion, and some are poisons by other routes. Most are suspect human carcinogens and experimental tumorigens, and exhibit experimental reproductive effects. They have two distinct actions on the body: a skin effect (chloracne) and a toxic action on the liver. The higher the chlorine content, the more toxic the PCBs tend to be.

- The OSHA PEL is listed as 0.5 mg/m³ for 54% chlorine content (as a PCB) and 1.0 mg/m³ for 42% chlorine content (as a PCB).
- The Cal/OSHA PEL is listed as 0.5 mg/m³ for 54% chlorine content (as a PCB) and 1.0 mg/m³ for 42% chlorine content (as a PCB).
- The TLV is listed as 0.5 mg/m³ for 54% chlorine content (as a PCB) and 1.0 mg/m³ for 42% chlorine content (as a PCB).

Note: Published exposure limits designate a skin notation indicating that dermal contact can contribute to the overall exposure.

3.2 Hazard Communication

In accordance with the Hazard Communication standard, material safety data sheets (MSDSs) will be maintained on site for chemical products used by BC personnel at the Site (i.e., spray paint, PVC cement, etc.). Subcontractors will be responsible for maintaining MSDSs for chemical products they bring on Site. In addition, containers will be clearly labeled in English to indicate their contents and appropriate hazard warnings. Please note that labeling containers includes, but is not limited to, any waste, used PPE, and/or decontamination materials collected.

3.3 Opening Wells and Well Vaults

Direct-reading instrumentation specified in Section 5 will be used to monitor any work in a well vault at the site where VOCs are a concern. The well vault will be opened carefully with the BC employee staying upwind as much as possible and then left open for a minimum of three minutes to allow the vault to vent. If the well cap is then removed, allow another three minutes for the well head to vent before proceeding. Please note that if there are other established protocols that differ from 3 minutes; the more protective time increment will be followed. Personnel should stay upwind as much as possible while working in and around the vault.

When removing a well cap, personnel will remain upwind as much as possible and will carefully remove the cap by opening it away from them in order to minimize the likelihood of exposure to vapors. Personnel will wait a minimum of three minutes to allow the well to vent before proceeding.

3.4 Physical Hazards

The following physical hazards, as marked below, have been identified and may be encountered during scheduled field activities.

- | | |
|--|--|
| <input checked="" type="checkbox"/> Slips, Trips and Falls | <input checked="" type="checkbox"/> Housekeeping |
| <input checked="" type="checkbox"/> Heavy Equipment | <input checked="" type="checkbox"/> Materials and Equipment Handling - Lifting |
| <input checked="" type="checkbox"/> Excavations | <input checked="" type="checkbox"/> Drilling |
| <input checked="" type="checkbox"/> Noise | <input checked="" type="checkbox"/> Underground Utilities |
| <input checked="" type="checkbox"/> Overhead Utilities | <input checked="" type="checkbox"/> Equipment Refueling |
| <input checked="" type="checkbox"/> Electrical Equipment | <input type="checkbox"/> Lockout/Tagout |
| <input type="checkbox"/> Confined Spaces | <input checked="" type="checkbox"/> Fire |
| <input checked="" type="checkbox"/> Sharp Objects/Cutting | <input checked="" type="checkbox"/> Cutting Acetate Sleeves |
| <input type="checkbox"/> Elevated Platforms | <input type="checkbox"/> Ladder Use |
| <input checked="" type="checkbox"/> Traffic | <input checked="" type="checkbox"/> Driving |
| <input type="checkbox"/> Arc Flash Protection | <input type="checkbox"/> Boating Safety |
| <input checked="" type="checkbox"/> Building Collapse | <input checked="" type="checkbox"/> Personal Safety – Urban Setting |

Actions to be taken to protect against the hazards identified are provided in the sections below.

3.4.1 Slip, Trips and Falls

Slipping hazards may exist due to uneven terrain, wet or slick surfaces, leaks or spills. Tripping hazards may be present from elevation changes, debris, poor housekeeping or tools and equipment. Some specific hazards may include: climbing/descending ladders, scaffolding, berms or curbing. Collectively, these types of injuries account for nearly 50 percent of all occupational injuries and accepted disabling claims. Prevention requires attention and alertness on the part of each worker, following and enforcing proper procedures, including good housekeeping practices, and wearing appropriate protective equipment.

3.4.2 Housekeeping

Personnel shall maintain a clean and orderly work environment. Make sure that all materials stored in tiers are stacked, racked, blocked, interlocked, or secured to prevent sliding, falling, collapse, or overturning. Keep aisles and passageways clear and in good repair to provide for free and safe movement of employees and material-handling equipment. Do not allow materials to accumulate to a degree that it creates a safety or fire hazard.

During construction activities, scrap and form lumber with protruding nails and other items shall be kept clear from work areas, passageways, and stairs. Combustible scrap and debris shall be removed at regular intervals. Safe means must be provided to facilitate removal of debris.

Containers must be provided for collecting and separating waste, used rags and other debris. Containers used for garbage and other oily flammable or hazardous waste such as caustics, acids,

harmless dusts, etc., must be separated and equipped with covers. Garbage and other waste shall be disposed of at frequent and regular intervals.

3.4.3 Heavy Equipment

Equipment, including earth-moving equipment, drill rigs, or other heavy machinery, will be operated in compliance with the manufacturer's instructions, specifications, and limitations, as well as any applicable regulations. The operator is responsible for inspecting the equipment prior to use each work shift to verify that it is functioning properly and safely.

The following precautions should be observed whenever heavy equipment is in use.

- PPE, including steel-toed boots, safety glasses, high visibility vests, and hard hats must be worn.
- Personnel must be aware of the location and operation of heavy equipment and take precautions to avoid getting in the way of its operation. Workers must never assume that the equipment operator sees them; eye contact and hand signals should be used to inform the operator of the worker's intent.
- Personnel should not walk directly in back of, or to the side of, heavy equipment without the operator's knowledge. Workers should avoid entering the swing radius of equipment and be aware of potential pinch points.
- Nonessential personnel will be kept out of the work area.

3.4.4 Materials and Equipment Handling - Lifting

The movement and handling of equipment and materials on the Site pose a risk to workers in the form of muscle strains and minor injuries. These injuries can be avoided by using safe handling practices, proper lifting techniques, and proper personal safety equipment such as steel-toed boots and sturdy work gloves. Where practical, mechanical devices will be utilized to assist in the movement of equipment and materials. Workers will not attempt to move heavy objects by themselves without using appropriate mechanical aids such as drum dollies or hydraulic lift gates.

Proper lifting techniques include the following.

- Lift with the strength of your knees, not your back.
- Firmly plant your feet approximately shoulder-width apart.
- Turn your whole body, don't bent or twist at the waist.
- Be sure that the path is clear of obstructions or tripping hazards; avoid carrying objects that will obstruct your vision.
- Use caution when holding an object from the bottom to prevent crushing of the hands or fingers when lowering.

3.4.5 Excavations

A competent person who is capable of identifying existing and predictable hazards in the surroundings, or working conditions that are unsanitary, hazardous, or dangerous to employees, and

who has authorization to take prompt corrective measures to eliminate them, will be present during excavation activities.

The atmosphere will be tested in excavations, before employees are permitted to enter and begin work, greater than 4 feet in depth or where oxygen deficiency or toxic or flammable gases are likely to be present. The atmosphere shall be ventilated and re-tested until flammable gas concentrations less than 5 percent of the lower explosive limit (LEL) and site-specific action levels are obtained. Worker entry will not be allowed if the oxygen concentration is less than 20 percent. In addition, a safe means of access and egress (i.e., a ladder, stairs or ramp) must be provided so that no more than 25 feet of lateral travel is required by employees.

Workers will not enter unstable excavations or excavations greater than 5 feet in depth without appropriate protective systems such as benching, sloping, or shoring. If shoring or shielding systems are not used, side slopes will not be steeper than 1½:1 without written confirmation from the competent person that slope is safe for the soil conditions. Excavations will be constructed in accordance with the OSHA Excavation Safety Standard (29CFR1926 Subpart P).

The competent person will inspect excavations daily. If there is evidence that a cave-in or slide is possible, work will cease until the necessary safeguards have been taken. Excavated material will be placed far enough from the edge of the excavation (a minimum of 2 feet) so that it does not fall back into the opening or affect the integrity of the sidewall. At the end of each day's activities, open excavations will be clearly marked and secured to prevent nearby workers or unauthorized personnel from entering them. Remote sampling techniques will be the preferred method of sample collection in excavations.

3.4.6 Drilling

During all drilling activities, the operator must ensure that the appropriate level of protection and appropriate safety procedures are utilized. The operator will verify that equipment "kill switches" are functioning properly at the start of each day's use. Hard hats, steel-toed boots, and ear and eye protection will be required at all times when working around drill rigs. The proximity of underground and overhead utilities must be identified before any drilling is attempted. The rig may not be moved with the mast in the upright position.

Workers can effectively manage hazards associated with working around heavy equipment if a constant awareness of these hazards is maintained. These hazards include the risk of becoming physically entangled in rotating machinery, slipping and falling, impact injury to eyes, head and body, and injury from machinery operations. Never work or walk on piles of well casings. Make sure all high-pressure lines and hoses have whip checks attached. Constant visual or verbal contact with the equipment operator will facilitate such awareness.

3.4.7 Noise

Noise may result primarily from the operation of heavy equipment, process machinery or other mechanical equipment. Hearing protection with the appropriate noise reduction rating (NRR) shall be worn in areas with high noise levels. A good rule of thumb to determine if hearing protection is needed is the inability to have a conversation at arms length without raising voice levels. If loud noise

is present or normal conversation becomes difficult, hearing protection in the form of ear plugs, or equivalent, will be required.

3.4.8 Underground Utilities

Reasonable efforts will be made to identify the location(s) of underground utilities (e.g., pipes, electrical conductors, fuel lines, and water and sewer lines) before intrusive soil work is performed. The state underground utility notification authority (e.g., USA, Dig Alert, Blue Stake, etc.) will be contacted prior to the start of intrusive field activities in accordance with local notification requirements. In areas not evaluated or serviced by the underground utility notification authority, and a reasonable potential for underground utilities exists, one or more of the following techniques will be employed to determine the location of subsurface structures.

- Contracting the services of a qualified private utility locator.
- Having a survey of the subject area conducted by staff trained in the use of subsurface utility locating equipment.
- Subsurface testing (i.e., hand digging or potholing) to the expected depth of probable utilities (not less than 5 feet).

If utilities cannot be located or if unlocated utilities are suspected to be present, subsurface activities (i.e., borings, excavation) should not be conducted before the location(s) or absence of underground utilities is confirmed.

Typical subsurface location marks are as follows:

- Red – electrical,
- Yellow – gas/oil/steam,
- Blue – water,
- Green – sanitary/storm drains/culverts,
- Orange – communications, and
- White – proposed excavation or boring.

Intrusive work should be limited to the area 3.3 feet (1 meter) on either side of the location marks. In some special cases such as fiber optics and high-pressure pipelines this area should be expanded to 16.5 feet (5 meters) on either side of the utility.

3.4.9 Overhead Utilities

If work is to be conducted in the vicinity of overhead electrical utilities, the owner of the overhead line will be contacted to determine the maximum voltage. Any overhead utility will be considered to be energized unless and until the person owning or operating such line verifies that the line is not energized, and the line is visibly grounded at the work site.

Workers will not perform work in proximity to energized high-voltage lines (including scaffolding, well drilling, pile driving, or hoisting equipment) until danger from accidental contact with high-voltage lines has been effectively guarded against.

Equipment with articulated upright booms or masts are not permitted to operate within 15 feet of an overhead utility line (less than 50kV) while the boom is in the upright position. For transmission lines in excess of 50kV, an additional distance of 4 inches for each 10 kV over 50kV will be used.

3.4.10 Equipment Refueling

Care shall be exercised while refueling generators, pumps, vehicles, and other equipment to prevent fire and spills. Personnel shall eliminate static electricity by grounding themselves (touching metal) prior to using refueling hoses and or containers of petroleum liquids. Items being refueled shall be grounded or be located on the ground and not on a trailer, work bench or inside a truck bed.

Equipment that is hot must be allowed to cool prior to refueling. Spill response materials shall be available when conducting refueling operations.

3.4.11 Electrical Hazards

Electrical equipment to be used during field activities will be suitably grounded and insulated. Ground-fault circuit interrupters (GFCI), or equivalent, will be used with electrical equipment to reduce the potential for serious electrical shock. Electrical equipment including batteries, generators, panels and extension cords shall be kept dry during use. Extension cords may not be used as a permanent means of providing power and will be removed from service if they are worn, frayed, or if the grounding prong is missing.

Extension cord precautions include the following.

- Be aware of exposed or bare wires, especially on metal grating. Warning: *Electrical contact with metal can cause fatal electrocution.*
- Prior to use, inspect cords for exposed or bare wires, worn or frayed cords, and incorrect splices. Splices are permitted, but there must be insulation equal to the cable, including flexibility.
- Cables and extension cords in passageways, steps or any area where there may be foot traffic should be secured so as to not create a tripping hazard. Overhead cables and extension cords shall be rigged to a height greater than 6 feet.
- Shield extension cords that must run across driveways or areas where vehicle traffic is present.
- Do not run cords across doorways or windows where they can be frayed or cut by a closed door or window.
- Do not run wires through wet or puddled areas.
- Flexible cord sets that are used on construction sites or in damp locations shall be of hard usage or extra hard usage type.

Observation of energized machinery will take place from a safe distance. Only qualified personnel will remove guards, hatch covers, or other security devices if necessary. Equipment lockout procedures and an appropriate facility work permit requirements will be followed. Lockout/tagout procedures will be conducted before activities begin on or near energized or mechanical equipment that may pose a hazard to site personnel. Workers conducting the operation will positively isolate the piece of equipment, lock/tag the energy source, and verify effectiveness of the isolation. Only

employees who perform the lockout/tagout procedure may remove their own tags/locks. Employees shall complete lockout/tagout training before initiating this procedure.

Only qualified personnel will remove covers of electrical equipment to expose energized electrical parts. Entering electrical rooms/vaults or areas with live exposed electrical part by BC employees shall be permitted only when accompanied by a qualified personnel after notification and approval of the appropriate facility personnel.

3.4.12 Lockout/Tagout

Lockout/tagout (LO/TO) procedures in accordance with 29 CFR 1910.147 will be performed before activities begin on or near energized or mechanical equipment that may pose a hazard to site personnel. The purpose of the lockout/tagout (LO/TO) system is to safeguard exposure from machinery, energized electrical circuits, piping under pressure, or any type of energy source from unexpected energizing or start up that could at cause harm to an individual. Workers conducting the operation will positively isolate the piece of equipment, lock/tag the energy source, and verify effectiveness of the isolation. Only employees who perform the lockout/tagout procedure may remove their own tags/locks. Employees must be thoroughly trained before initiating this procedure.

Whenever multiple personnel (or multiple employers are working on the same worksite) are to be engaged in activities requiring LO/TO, employees/employers shall inform each other of their activities and coordinate their respective LO/TO procedures. Whenever a group lockout/tagout procedure must be performed, they shall utilize a procedure that affords the same level of protection as that provided by the implementation of a personal lockout or tagout device. Group LO/TO devices shall meet the requirements of 29 CFR 1910.145(f)(3).

Basic Lockout/Tagout Procedures

1. Each person will maintain their own lock, key, and lockout device so that no one else can remove the lock.
2. Always notify the operator when work is to be done.
3. Use your own lock to lock out electrical power. Attach a tag or sign to the power disconnect to indicate that maintenance work is in progress. Use the wording "Do Not Operate."
4. Bleed all pressure from pneumatic, hydraulic, or other fluid lines, or safely isolate them from the area where work is being done.
5. Drain contents of lines or tanks as needed. Lock valves open or closed to prevent buildup of pressure.
6. Ground electrical systems as needed.
7. Secure any device under tension or compression so as to prevent accidental movement. Move suspended parts that could drop or cycle to a safe position and block, clamp, or chain them in place.
8. Verify (test) that the mechanism had been isolated from the source of energy.

9. Ensure that all workers remove their individual locks after work is completed. The last worker should remove the locking devices.
10. Ensure that the last person double-checks that all is clear and safe before start-up.

Portable Equipment

Portable electrical equipment such as hand drills, computers, and power saws that use plug type connectors must be unplugged prior to any task that may expose the employee to energized portions of the equipment. Removal of the plug from the power source, such as the generator or wall socket, may be combined with a tagout system, particularly if the plug is at a distance from the equipment being repaired.

3.4.13 Confined Spaces

Entry into confined spaces will be conducted in strict accordance with 29 CFR 1910.146. Confined spaces will be evaluated prior to entry to determine if hazards are present that could pose a risk to entrants. Before workers may enter a permit-required confined space, a pre-entry checklist and entry permit must be completed by the PM or SSO, approved by the RSUM and, all requirements for entry must be met.

Confined spaces may be described as having, but not being limited to, the following characteristics:

- is large enough to permit an employee to enter and perform work; and
- has limited or restricted means of entry and exit; and
- is not equipped, designed, or intended for continuous human occupancy.

If there is any serious health and safety hazard present in the confined space is considered a permit-required confined space (permit space). A permit-space is a confined space that has one or more of the following characteristics:

- contains or has the potential to contain a hazardous atmosphere; or
- contains or has the potential to contain a material with the potential to engulf or entrap an employee; or
- is so configured that an employee may become trapped, disoriented, or asphyxiated by wall configurations or floors that taper to smaller cross sections; or
- contains any other established safety or health hazard (examples may include sources of energy, moving parts or thermal considerations).

All fluid, electrical, and steam lines and other sources of energy that could harm entrants must be completely isolated before entry. The following atmospheric conditions must be met before entry is permissible (air monitoring may be necessary to verify these conditions are met):

- flammable vapor or dust must be at a concentration less than 5 percent of the lower explosive limit (LEL); and
- oxygen must be at a concentration greater than 20 percent and less than 22 percent; and
- hydrogen sulfide concentration must be less than 5 parts per million (ppm); and
- toxic substances must be at a concentration less than their respective permissible exposure limits or specified action limits.

In addition, the following roles must be designated before entry into permit-required confined spaces is allowed: Entry Supervisor; Attendant; and Authorized Entrant(s). Confined space entry for each project also requires training for the project team on written operating procedures, including the use of the Confined Space Pre-Entry Checklist and Confined Space Entry Permit forms.

BC employees are **not** trained in rescue services. Such services are to be arranged locally, prior to entry operations, by the PM. Rescue services can typically be provided by the local fire department or contracted service provider.

3.4.14 Fire/Explosion

Site workers should have an increased awareness concerning fire and explosion hazards whenever working with or near flammable materials, especially when performing any activity that may generate sparks, flame, or other source of ignition. Intrinsically safe equipment is required when working in or near environments with the potential for an explosive or flammable atmosphere. The SSO will verify facility requirements for a “hot work” permit before activities that may serve as a source of ignition are conducted.

Flammable materials will be kept away from sources of ignition. In the event of fire, work will cease, the area will be evacuated, and the local fire response team will be notified immediately. Only trained, experienced fire fighters should attempt to extinguish substantial fires at the Site. Site personnel should not attempt to fight fires, unless properly trained and equipped to do so. A fully charged ABC dry chemical fire extinguisher will be readily available for use during all scheduled activities at the Site.

3.4.15 Sharp Objects/Cutting Utensils

Frequently field tasks require the cutting of items such as rope, packaging or containers. Care should be exercised in using knives and/or cutting implements while performing such cutting tasks. Personnel should cut down and away from their body and other personnel. The item being cut should be braced or secured from movement while cutting. When slicing open acetate liners, such as those utilized in direct push drilling, personnel should use a hook blade cutting implement designed for this task versus a straight blade knife.

3.4.16 Cutting Acetate Sample Sleeves

The cutting of acetate sleeves presents a potential hazard to sampling personnel. By following proper procedures, the risk associated with this activity can be effectively minimized. To remove the soil sample the acetate liner must be cut with a bladed tool or knife. Knives are more frequently the source of disabling injuries than any other hand tool. The principal hazard in the use of knives is the hand slipping from the handle onto the blade or the blade strikes another part of the body. To prevent this, the following safety procedures should be followed.

- Provide a safety blade holder with a retraction spring on a track where blade mounts. Use a hook type linoleum blade which has a reduced cutting edge. When the hook of the blade is cutting the acetate liner it keeps the blade extended. If the blade breaks or the operator's hand slips the blade automatically retracts into the handle of the safety blade holder.

- Replace blades when they become dull. If material becomes hard to cut the blade is dull.
- Wear leather cut-resistant (such as Kevlar) gloves.
- Wear safety glasses.
- The cutting stroke should be away from the body. If that is not possible, then the hands and body should be in the clear.
- Provide an angle iron device to place the liner in when cutting. This gives a holder for the liner.
- If you drop the knife just let it fall to the ground and DO NOT try to catch it.
- If you lay the knife down make sure the blade is retracted into the holder or the knife is placed in a protective holder.

3.4.17 Elevated Platforms

When working at heights that expose employees to falls greater than 6 feet, especially on sloping roofs and elevated platforms, the requirements of 29 CFR 1926.502 shall be observed. In such instances, a safety harness shall be worn and the lanyard secured at a level not lower than the employee's waist, limiting the free-fall distance to a maximum of 6 feet.

Elevated work platforms shall be constructed, used, and maintained in accordance with Subpart L of the OSHA Construction Safety Orders. Scaffolds and hoisting lines shall be inspected daily by a competent person to verify the integrity of the components. If a material is determined to be defective, it may not be used for any purpose and will be replaced immediately.

A standard railing shall consist of top rail, intermediate rail, toe board, and post. It shall have a vertical height of approximately 42 inches (± 3 inches) from the top surface of the top rail to the floor, platform, runway, or ramp. The top rail shall have a smooth surface throughout. The intermediate rail shall be set half way between the top rail and the floor, platform, runway, or ramp.

A cover of standard strength and construction that is secured against accidental displacement shall guard floor holes, hatchways, or any other openings into which a person can walk. When the cover is not in place, the openings shall be guarded with a standard railing (equipped with a toe board) on all exposed sides. Any cover on floor openings shall be properly labeled or stenciled with letters at least one inch high or greater stating "OPENING – DO NOT REMOVE".

Personal Fall Protection Equipment

Full body harness is the only acceptable means of fall arrest for personnel working over surfaces greater than six feet in height. A Fall Arrest System consisting of safety harness and anchor lanyard must be worn by anyone working on elevated surfaces that lack "general" fall protection such as railings, etc.

Lanyards must be tied off at a point above the worker's head and to a firm structure or a portion thereof designed to hold a weight of 5,000 lbs. Only hooks with locking snaps that operate in "as new" condition will be used. These hooks are also referred to as "double action lanyard hooks".

When other possible means of fall protection (railings, etc.) are not available, individuals working at heights of less than 6 feet must tie-off if there is danger of impalement, especially if the impalement hazard cannot be mitigated in accordance with OSHA standards.

All workers must perform routine inspection of belts/harnesses and lanyards prior to their use. The employer shall conduct regular inspections (every three months) of all fall protection equipment. In addition, there shall be an inspection of all workers' personal tools and equipment prior to the employees using them on the job.

Lanyards are to be used for tie-off purposes only, and damaged belts, harnesses, and lanyards must be retired and discarded.

3.4.18 Ladder Use

Ladders are to be maintained in good condition at all times, with tight joints, hardware, and fittings securely attached, and moveable parts freely operating without binding or undo play. Defective ladders must be "tagged" out of service. Safety "feet" shall be kept in good condition. Ladders are to be visually inspected for possible signs of damage or defects daily, before each use.

Where possible, portable straight rung ladders shall be set up so that the horizontal distance from the top support to the foot of the ladder is $\frac{1}{4}$ of the working length of the ladder. The ladder shall be secured by tying it off to a firm point, or held in place by another worker while in use. If the ladder is used to gain access to a roof or platform, the side rails shall extend at least 3 feet beyond the point of support at the edge of the roof or platform.

Step ladders shall always be set up properly, so that they are in the "A" frame position, level and with all four feet on firm ground, and fully opened with the spreaders locked in place. Personnel are forbidden to stand on the top cap or on the last step of a step ladder, or to stand on the hinged back of a step ladder. A step ladder shall never be used at a straight ladder.

3.4.19 Traffic

Vehicular traffic presents opportunities for serious injury to persons or property. Traffic may consist of street traffic or motor vehicles operated by facility employees or visitors to the Site. Workers and other pedestrians are clearly at risk during periods of heavy traffic. Risk from motor vehicle operations may be minimized by good operating practices and alertness, and care on the part of workers and pedestrians.

Site personnel will wear high-visibility traffic safety vests whenever activities are conducted in areas of heavy traffic. Work vehicles will be arranged to be used as a barrier between site workers and nearby traffic. If required by local ordinances or site location, a traffic control plan will be developed implemented.

It is important to be conscious of all vehicular traffic that may be present during conduct of field operations. Use caution tape, barricades, or safety cones to denote the boundaries of the work area and to alert vehicle operators to the presence of operations which are non-routine to them. Be careful when exiting the work area and especially when walking out from between parked vehicles to avoid vehicular traffic.

Never turn your Back on Traffic. When working in or near a roadway, walk and work with your face to the oncoming traffic. If you must turn your back to traffic, have a coworker watch oncoming traffic for you.

Vehicle and Worksite Position. Whenever possible, place a vehicle between your worksite and oncoming traffic. Not only is the vehicle a large, visible warning sign, but if an oncoming car should fail to yield or deviate, the parked vehicle, rather than your body, would absorb the first impact of a crash. Turn the wheels so that if the vehicle were struck, it would swing away from the worksite. Even though the vehicle would protect you in a crash, it might be knocked several feet backward. Always leave some room between the rear of the vehicle and the work area.

Use of Signs and Cones to Direct Traffic. Traffic signs and cones are used to inform drivers and direct traffic away from and around you. Cones and signs are only effective if they give oncoming drivers enough time to react and make it clear how traffic should react.

Cone Positioning. The most common coning situation is setting a taper of cones that creates a visual barrier for oncoming motorists and gradually closes a lane.

The position of the taper depends on the road width, position and size of the work area, and also on the characteristics of the traffic.

3.4.20 Driving

A lot of driving is required to get to, from, and between project Sites. Safe vehicle maintenance and operation must be a priority. It requires knowledge of directions to (and conditions of) the Site in advance, careful exiting and merging into traffic, anticipating the unexpected, remaining alert to one's physical and mental condition, resisting distractions such as cell phone use, other car activities and contacting assistance when needed. Report all vehicle accidents/incidents to BC's Risk Manager.

3.4.21 Arc Flash Protection

An arc flash is a short circuit through the air when insulation or isolation between electrified conductors is breached or can no longer withstand the applied voltage, an arc flash occurs. Statistics show that there are 5 to 10 arc flash explosions a day near electrical equipment that result in hospitalization of a burn victim. An arc flash can be caused by common occurrences such as dropping tools, accidental contact with electrical systems, and build up of dirt or corrosion.

The temperature of an arc can reach more than 35,000 F as it creates a brilliant flash of light and a loud noise. Concentrated energy explodes outward from the electrical equipment, spreading hot gases, melting metal, causing death or severe burns, and creating pressure waves that can damage hearing or brain function and a flash that can damage eyesight. The fast-moving pressure wave also can send loose material such as pieces of equipment, metal tools, and other objects flying, injuring anyone standing nearby.

Regulations require the calculation of the "flash protection boundary" inside which qualified workers must be protected when working. This boundary is an imaginary sphere surrounding the potential arc point, "within which a person could receive a second-degree burn if an electrical arc flash were to occur," according to the National Fire Protection Association (NFPA) 70E standard.

Brown and Caldwell's Health and Safety Manual gives direction of when and where to establish this boundary.

BC's Electrical Safety/Arc Flash Policy provides information and instruction for BC employees who work on or near energized power circuits, electrical distribution equipment, electrical utilization equipment and those who inspect energized equipment, where a phase-to-ground or phase-to-phase short or fault occurrence may cause an Arc Flash event.

BC employees shall comply with BC Health and Safety Requirements Manual # 207 – Lockout/Tagout and treat electrical equipment and circuits as energized until:

1. Lock-Out / Tag-Out protection is in place and the equipment or circuit has been tested to verify “no voltage” present, by a trained and qualified electrical worker, or
2. The equipment or circuit has been physically isolated from every power source, tested, and clearly labeled.

For those BC employees involved with **energized electrical work** (i.e. design verification, equipment check-out, or start-up adjustments), the following ordered approach shall be used:

1. BC employees shall seek to have a trained and qualified electrical worker perform all energized electrical hands-on work (i.e. switching, metering, testing, etc.) while BC employees remain outside the flash protection boundary.
2. BC employees that closely supervise work within the flash protection boundary shall first receive approval from the Project Manager and Site Safety Officer (SSO).
3. Prior to performing this work, the Project Manager (PM) shall ensure that a Field Work Safety Plan (FWSP) is prepared and approved by the PM, the employee's manager, the SSO, and cognizant Health and Safety Manager.
4. Only “qualified BC employees” shall enter the flash protection boundary wearing the proper Personal Protective Equipment (PPE) and only for Hazard/Risk Categories 0-2 – see the ‘Warning’ section below. BC personnel shall acquire the proper PPE from the SSO and/or RSUM.

WARNING

Qualified BC personnel are limited to work in Hazard/Risk Categories 0-2, and therefore only require PPE meeting the requirements of Hazard/Risk Categories 0-2.

Only qualified electricians shall conduct work categorized as a Hazard/Risk Category of 3 or 4.

Qualified BC personnel are NOT to cross a flash protection boundary which involves a Hazard/Risk Category 3 or 4 situation.

BC employees and management shall review the **Health and Safety Manual #513 – Arc Flash** for detailed requirements.

Questions concerning this policy should be directed to the BC Office Electrical Engineering Manager and to the RSUM.

Definitions

Energized Electrical Work. Work performed on or near energized electrical systems or equipment with exposed components operating at 50volts or greater. Electrical system testing, thought to be de-energized, but not yet proven to be (for example, a LO/TO effectiveness check).

Flash Protection Boundary. The distance from energized exposed electrical equipment at which an unprotected person will receive a curable burn: 2nd degree burn or blistering. Work performed inside this boundary requires that the person be a “qualified person” and the use of Personal Protective Equipment (PPE) to protect against arc flash burns.

Newly installed/serviced electrical equipment may contain an Arc Flash Label that will identify the energy, hazard category and PPE requirements associated with the equipment. For all other unlabeled equipment, where the specific flash protection boundary (energy, hazard category, and applicable PPE) is not established or cannot be established first (prior to live electrical exposure), BC personnel shall maintain a 4-foot minimum observation distance (BC prefers 10 feet) from the exposed (i.e. doors open, covers off) live electrical equipment. In the event that the 4-foot minimum distance must be crossed, BC personnel shall don PPE appropriate for Hazard/Risk Category 2.

Qualified BC Employee. A person with the training and experience having knowledge of energized electrical equipment hazards from an operational standpoint and from the safety training standpoint.

Educational credentials alone do not make a person qualified. Determination of qualification shall be established by the employee’s supervisor or other designated knowledgeable management representative.

3.4.22 Boating Safety

Boating or similar activities on aerated water treatment ponds and/or tanks by BC personnel is not permitted. The aeration process affects the buoyancy of the liquid and therefore boats can not consistently stay afloat.

Performing work activities from a boat can present unique hazards to employees. The following guidelines can help mitigate the risk. The boat can become unstable if the weight in it is excessive or loaded improperly. Too much weight will reduce maneuverability and freeboard (the height of the boat sides above the water) and can increase the risk of sinking.

When boarding the boat, the operator must be sure that the boat is secure. With one hand on the boat, each employee should quickly lower themselves straight down into the center of the boat. A United States Coast Guard (USCG) certified personal floatation device will be worn by each BC employee in the boat. In addition, other USCG-required items (i.e., throwable cushion, retrieval line, etc.) will be present on the boat. To move around in a boat, one should step along the fore-and-aft centerline of the boat while the boat is held in place along the pier.

Do not board the boat while carrying equipment, rather first board the craft and then have someone hand in the equipment or place the equipment in the boat prior to launch. The amount and location of weight is critical and can reduce the risk of capsizing. Weight should be kept towards the middle or centerline of the boat, both fore-and-aft and side-to-side, also the weight should be kept low to the bottom of the boat to reduce the center of gravity.

It is not anticipated that waves of substantial size will be encountered, however, if a wave approaches the boat, steer the bow towards the oncoming wave. Overloading the boat increases draw and the potential for swamping. Watercraft must be operated within the boat manufacturers weight limits.

Should the boat capsize, Brown and Caldwell personnel shall abandon the boat and return to shore as quickly as possible. It is important that the employees attempt to remove themselves from the water as soon as possible, and get inside and call for help. Hypothermia (cold stress) is a significant risk for anyone involved in a boating accident due to the rapid conduction of body heat by cold water. Wet or dry suits are recommended for cold weather/cold water (less than 45° F) operations.

3.4.23 Building Collapse

Buildings collapse for a variety of reasons. Natural phenomena such as earthquakes, hurricanes, floods, mudslides, avalanches, and storms are the usual cause for building collapses. Vacant buildings may be at risk for collapse since maintenance-related activities have been often neglected thus resulting in structural damage.

Project personnel should attempt to answer the following questions whenever working near suspect building structures.

- Are there any vacant buildings present on site?
- Will it be necessary to enter or work next to the vacant building(s)?
- Are there any apparent hazards including external damage, falling objects, sticky doors, structural instability, or possible asbestos and/or lead paint?
 - External damage may include, but not necessarily be limited to, foundation cracks, damaged or missing porch roofs and overhangs supports, gaps between steps and the structure, missing supports or portions of walls, and “washed away” ground.
 - Falling objects may include, but not necessarily be limited to, building cornices, gutters, bricks, and roofs/roofing materials.
- Be aware that when entering a building, if the door sticks at the top it could mean the ceiling is ready to fall. If you force the door open, stand outside the doorway clear of falling debris.
- Has the building(s) been inspected by a qualified professional and deemed safe for entry?
- Are there any viable alternatives for conducting work that preclude the need to enter or work next to the suspect building(s)?

If you have any concerns about entering the building after answering the above questions, speak with the PM immediately. The client will need to be informed that a proper building inspection or engineering controls may be needed before work can be performed.

If you don't feel safe entering a building, then notify the PM and RSUM and stay outside the building at an appropriate distance to avoid falling debris.

3.4.24 Personal Safety - Urban Setting

Working in a distressed neighborhood may present hazards associated with street violence or other crime. In these situations, mental preparation before going to the Site and awareness while on Site

are of key importance. If in doubt, always ask Site or client personnel about the safety of a neighborhood. Forethought should be given to arranging to work during daylight hours if possible. Take advantage of any Site security measures (monitoring cameras, security guards) and investigate such measures prior to the field work. Once in the field, work in parties of two or more and stay within view of the general public. Keep a charged cell phone nearby or on your person at all times. Become familiar with your location so you can effectively communicate it over the phone.

In addition to these basic principals, the following is a list of common personal safety rules that apply not only to work at the Site, but to general safety practices while in the field and also between work shifts.

- If at all possible, work/travel in groups. Do not venture out alone.
- Be alert. Notice who passes you and who's behind you. Maintain distance between yourself and strangers. Know where you are, and note potential exit paths.
- If work has paused do not appear slack or distracted. Do not sit in a vehicle with the doors unlocked.
- Walk in well-lighted areas. Don't walk close to bushes, alleys, and so on. In dark or deserted neighborhoods, walk down the middle of the street (be alert to vehicle traffic).
- If a car pulls up slowly, or the occupants of the vehicle bother you, cross the street and walk or run in the other direction. If you are pursued, dial 911.
- If you feel someone is following you, turn around and check. Proceed to the nearest lighted house or place of business.
- Don't overburden yourself with bags or packages, which might impede running or taking care of yourself.
- Be aware of loose clothing, packs/purses and hair. These give an assailant an easier method of grabbing and controlling you. Wear unrestrictive clothing for ease of movement (but not overly loose).
- Carry a non-weapon personal safety device (such as a whistle, panic button, or key light) - anything that could visually or audibly draw attention to your location.
- What you carry in your hand(s) is important. Valuables make you a potential target. Items such as a hand auger or tool may help you be perceived as a less-than-inviting victim.
- Carry as little cash as possible.
- Hold your purse tightly, close to your body. Keep your wallet in a front or in a buttoned, hip pocket. When at a fixed location, lock your valuable items away and out of site (i.e., in a trunk).
- Be careful when people stop you for directions or information. Always reply from a distance; never get too close to a stranger's car.
- If you feel that you are in danger, don't be afraid to scream and run.
 - Toss wallet/keys away from direction of escape.
 - Don't attach car keys to house keys.
 - Leave large valuables (purse, laptop) locked and hidden in the vehicle.

3.5 Natural Phenomena

Natural phenomena such as weather-related emergencies and acts of nature can affect employees' safety. Natural phenomena can occur with little or no warning. If an emergency situation arises as a result of natural phenomena, adhere to the contingency procedures outlined in Section 10. The following natural phenomena have been identified and may be encountered during scheduled field activities.

- | | |
|---|--|
| <input checked="" type="checkbox"/> Sunburn | <input checked="" type="checkbox"/> Heat Stress |
| <input checked="" type="checkbox"/> Cold Stress | <input checked="" type="checkbox"/> Lightning/Electrical Storms |
| <input type="checkbox"/> Hurricanes | <input checked="" type="checkbox"/> Tornadoes and Strong/Straight Line Winds |
| <input type="checkbox"/> Earthquakes | |

3.5.1 Sunburn

Working outdoors with the skin unprotected for extended periods of time can cause sunburn to the skin. Excessive exposure to sunlight is associated with the development of skin cancer. Field staff should take precautions to prevent sunburn by using sunscreen lotion and/or wearing hats and long-sleeved garments.

3.5.2 Heat Stress

Adverse climate conditions, primarily heat, are important considerations in planning and conducting site operations. Heat-related illnesses range from heat fatigue to heat stroke, with heat stroke being the most serious condition. The effects of ambient temperature can cause physical discomfort, loss of efficiency, and personal injury, and can increase the probability of accidents. In particular, protective clothing that decreases the body's ventilation can be an important factor leading to heat-related illnesses.

To reduce the possibility of heat-related illness, workers should drink plenty of fluids and establish a work schedule that will provide sufficient rest periods for cooling down. Personnel shall maintain an adequate supply of non-caffeinated drinking fluids on site for personal hydration. Workers should be aware of signs and symptoms of heat-related illnesses, as well as first aid for these conditions. These are summarized in the table below.

Condition	Signs	Symptoms	Response
Heat Rash or Prickly Heat	Red rash on skin.	Intense itching and inflammation.	Increase fluid intake and observe affected worker.
Heat Cramps	Heavy sweating, lack of muscle coordination.	Muscle spasms, and pain in hands, feet, or abdomen.	Increase fluid uptake and rest periods. Closely observe affected worker for more serious symptoms.

Condition	Signs	Symptoms	Response
Heat Exhaustion	Heavy sweating; pale, cool, moist skin; lack of coordination; fainting.	Weakness, headache, dizziness, nausea.	Remove worker to a cool, shady area. Administer fluids and allow worker to rest until fully recovered. Increase rest periods and closely observe worker for additional signs of heat exhaustion. If symptoms of heat exhaustion recur, treat as above and release worker from the day's activities after he/she has fully recovered.
Heat Stroke	Red, hot, dry skin; disorientation; unconsciousness	Lack of or reduced perspiration; nausea; dizziness and confusion; strong, rapid pulse.	Immediately contact emergency medical services by dialing emergency medical services. Remove the victim to a cool, shady location and observe for signs of shock. Attempt to comfort and cool the victim by administering small amounts of cool water (if conscious), loosening clothing, and placing cool compresses at locations where major arteries occur close to the body's surface (neck, underarms, and groin areas). Carefully follow instructions given by emergency medical services until help arrives.

3.5.3 Cold Stress

Workers performing activities during winter and spring months may encounter extremely cold temperatures, as well as conditions of snow and ice, making activities in the field difficult. Adequate cold weather gear, especially head and foot wear, is required under these conditions. Workers should be aware of signs and symptoms of hypothermia and frostbite, as well as first aid for these conditions. These are summarized in the table below.

Condition	Signs	Symptoms	Response
Hypothermia	Confusion, slurred speech, slow movement.	Sleepiness, confusion, warm feeling.	Remove subject to a non-exposed, warm area, such as truck cab; give warm fluids; warm body core; remove outer and wet clothing and wrap torso in blankets with hot water bottle or other heat source. Get medical attention immediately.
Frostbite	Reddish area on skin, frozen skin.	Numbness or lack of feeling on exposed skin.	Place affected extremity in warm, not hot, water, or wrap in warm towels. Get medical attention.
Trench Foot	Swelling and/or blisters of the feet	Tingling/itching sensation; burning; pain in the feet	Remove wet/constrictive clothing and shoes. Gently dry and warm feet with slight elevation. Seek medical attention.

3.5.4 Lightning/Electrical Storms

Lightning can be unpredictable and may strike many miles in front of, or behind, a thunderstorm. Workers will therefore cease field operations at the **first** sign of a thunderstorm and suspend activities until at least 30 minutes after the last observed occurrence of lightning or thunder. For purposes of this HASP, signs of a thunderstorm will include any visible lightning or audible thunder.

In the event of a thunderstorm, field personnel will take the following actions.

- Get inside a permanent building structure (not a shed or canopy) or fully enclosed metal vehicle (not a convertible or camper shell) with the windows fully up.
- If in a house or building, do not use the telephone or any electrical appliance that's connected to the building's electrical wiring.

- Stay away from tall isolated objects, such as trees, drill rigs, telephone poles, or flag poles.
- Avoid large open areas, such as fields or parking lots, where a person is the relatively highest object.
- Stay away from lakes, ponds, railroad tracks, fences, and other objects that could transmit current from a distant lightning strike.
- If caught out in the open without time to escape or find shelter, seek a low area (if time permits), crouch down, and bend forward holding the ankles. Tuck the head so that it's not the highest part of the body, without letting it touch the ground. Under no circumstances lay down.

If a person struck by lightning contact emergency medical services, even if he/she appears only stunned or otherwise unhurt as medical attention may still be needed. Check for burns, especially at fingers and toes, and areas next to buckles and jewelry.

3.5.5 Hurricanes

The key to responding to hurricane conditions is being informed. Before taking to the roads to leave for or from a jobsite during suspect hurricane conditions, listen to the radio for current and forecast conditions. Know what the weather reports mean by "watch" and "warning." A hurricane watch means hurricane conditions are possible in the specified area of the watch, usually within 36 hours. A hurricane warning indicates hurricane conditions are expected in the specified area of the warning, usually within 24 hours.

If watch or warning conditions exist, employees will communicate with the project manager to determine the appropriate course of action. Travel to or from work is not recommended if the employee will travel in the vicinity of a hurricane warning area. Restrictions on travel during hurricane watches are largely dependent on the actual weather conditions at the time. Employees are discouraged from driving during weather conditions where visibility and vehicle control are severely limited.

For long term projects with temporary or permanent office area, keep an emergency preparedness kit consisting of, but not limited to:

- Current project/office contacts list - how to reach folks in an emergency ,
- Blankets,
- Flashlights,
- Radio (operated by batteries),
- Batteries for flashlight and radio (note: batteries should be replaced annually to assure freshness) ,
- Water (unless there is a water bubbler that can be used with no electricity), and
- Snack crackers, dried fruit, etc. - a source of food that won't go bad.

3.5.6 Tornadoes and Strong/Straight Line Winds

Tornadoes and strong or straight line winds are potentially dangerous weather conditions because both have the ability to generate on very short notice (in some cases under one hour from clear

weather conditions). Tornadoes and strong or straight line winds both have the same warning properties and recommendations. If a tornado “watch” is issued for your area, it means that a tornado is “possible”. If a tornado “warning” is issued, it means that a tornado has actually been spotted, or is strongly indicated on radar, and it is time to go to a safe shelter immediately.

Be alert to what is happening outside, but do not place yourself in jeopardy by standing next to windows. Some common observations during a tornado include: a sickly greenish or greenish-black color to the sky; if there is a watch or warning announced or posted; an abrupt fall of hail (however, hail can occur in the absence of a tornado); a strange quiet that occurs within or shortly after a thunderstorm; clouds moving by very fast, especially in a rotating pattern or converging toward one area of the sky; a sound like a waterfall or rushing air at first, but turning into a roar as it comes closer (the sound of a tornado has been likened to that of both railroad trains and jets); debris dropping from the sky; an obvious “funnel-shaped” cloud that is rotating; or debris such as branches or leaves being pulled upwards, even if no funnel cloud is visible.

During a tornado warning or tornado occurrence, each employee is instructed to do the following:

- Proceed to interior rooms and halls on the lowest floor (***do not use an elevator to exit an upper floor***). Avoid halls that open to the outside in any direction. If there are no interior hallways, avoid those that open to the southwest, south, or west, since that is usually the direction from which the tornado will come.
- Stay away from glass, both windows and doors. Crouch down, and make as small a “target” as possible. If you have something with which to cover your head, do so, otherwise, use your hands.
- Exercise extreme caution when leaving your area of shelter. Be aware of potential hazards (i.e., natural gas smell, smoke, fire). In the event these hazards are encountered in your area of shelter, immediately evacuate the shelter. If the building/shelter has been damaged by a tornado, do not flush the toilets, as the sewer lines may have been damaged.
- If you are traveling in an automobile and can see a tornado, do not stay in your car and try to outrun a tornado. If possible, stop the car and enter the nearest business and seek shelter.
- If you are outside and it is not possible to get inside, seek a low lying ditch, culvert, etc. and keep your body as low to the ground and as braced as possible.

3.5.7 Earthquakes

Earthquakes strike suddenly, violently, and without warning. If your project is located near a fault line, earthquakes are an unpredictable possibility. For long term projects with temporary or permanent office area, keep an emergency preparedness kit consisting of, but not limited to:

- Current project/office contacts list - how to reach folks in an emergency,
- Blankets,
- Flashlights,
- Radio (operated by batteries),
- Batteries for flashlight and radio (note: batteries should be replaced as needed to assure freshness),
- Water (unless there is a water bubbler that can be used with no electricity), and

- Snack crackers, dried fruit, etc. - a source of food that won't go bad.

This kit is meant to serve as overnight survival in the event that it becomes unsafe to leave the project site. The kit's contents should be suited to meet the size and needs of your project.

If you feel the earth shaking, consider the following tips:

- Drop down; take cover under a desk or table and hold on.
- Stay indoors until the shaking stops and you are sure it is safe to exit.
- Stay away from bookcases, shelves, or anything that could fall on you.
- Stay away from windows.
- If inside a building, expect fire alarms and sprinklers to go off during the quake.
- If you are outdoors, find a clear spot away from buildings, trees, and power lines. Drop to the ground and cover your head.

If you are in a car, slow down and drive to a clear place, preferably away from power lines. Stay in the car until the shaking stops.

3.6 Biological Hazards

The following biological hazards have been identified and may be encountered during scheduled field activities.

- ☐ Bloodborne Pathogens/Sanitary Waste
- ☒ Rodents and Mammals
- ☒ Reptiles/Snakes
- ☒ Venomous Insects
- ☒ Mosquitoes
- ☐ Fire Ants
- ☒ Spiders/Scorpions
- ☒ Ticks
- ☒ Poisonous Plants

If any biological hazards are identified at the Site, workers in the area will immediately notify the SSO and nearby personnel.

3.6.1 Bloodborne Pathogens/Sanitary Waste

Potential exposure to bloodborne pathogens may occur during some work activities (e.g., sewer video surveys or source sampling), rendering first aid or CPR. Direct contact is an important route of exposure for bloodborne pathogens due to puncture injuries, contact with abraded skin, or contact with areas such as the eyes, without appropriate protection. While very few organisms can enter the body through normal intact skin, direct contact with sewage, blood and body fluids is to be avoided. Site personnel should thoroughly wash their hands and face before eating, drinking or smoking and before leaving the work site.

Exposure controls and Universal Precautions are required at suspect locations, in order to prevent contact with blood or other potentially infectious materials as specified in Brown and Caldwell's *Bloodborne Pathogens Program*. All blood or other potentially infectious material will be considered infectious regardless of the perceived status of the source individual. A Hepatitis B vaccination will be offered to BC personnel before the person participates in a task where direct exposure to potentially infectious materials is a possibility (i.e., first aid or CPR). For personnel who have potential exposure to sanitary wastes, a current tetanus/diphtheria inoculation or booster is recommended.

3.6.2 Rodents/Mammals

Animals may potentially carry the rabies virus or disease causing agents. Do not attempt to feed or touch animals. Feces from some small mammals may contain diseases such as Hanta Virus. Avoid generating dust in the vicinity of rodent feces. In addition, animals such as dogs or wild predators (i.e., cougars or coyotes) may pose an attack hazard. Persons should slowly back away in a non-threatening manner if an encounter with a threatening animal occurs. In order to avoid such encounters, use the buddy system and make noise when working in areas where such animals may be present.

3.6.3 Reptiles/Snakes

The primary reptiles of concern are venomous snakes (rattlesnake, water moccasin, and copperhead). Avoid contact and areas that may harbor snake populations including high grass, shrubs, and crevices. In the event of a bite, immobilize the affected area and contact emergency medical services. If more than 30 minutes from emergency care, apply bandage wrap two to four inches above the bite (**note:** bandage should be loose enough to slip your finger underneath).

Wear shoes and heavy pants when walking and hiking in areas where snakes are likely found. Do not reach into rocky cracks, under logs, or large rocks. Even if a snake looks dead, do not touch it. A snake can still bite up to one hour after its death. Do not get near or tease a snake. Snakes are shy creatures and generally will not attack unless bothered.

Diamond Back Rattle Snake

Diamond backs are large snakes. They have a row of dark diamonds down the back and a rattle on their tail. These snakes have cat-like eyes and a pit between their nostril and eye. Eastern diamond backs like pine flat woods and scrub areas where palmetto thickets and gopher tortoise burrows are found. These snakes travel during the day and hide at night.

Timber Rattle Snake

Timber rattle snakes have a reddish-brown stripe running down the center of their back and black crossbands. Their tails are solid black with a rattle. These snakes have cat-like eyes and a pit between their nostril and eye. Timber rattlers live in damp river beds, pine flat woods, swamps, and cane thickets.

Pygmy Rattle Snake

These small snakes are light to dark grey in color. They have a tiny rattle. Pygmy rattle snakes have cat-like eyes and a pit between their nostril and eye. These snakes are found in lowland pine flat

woods, prairies, around lakes, ponds, and swamps. Pygmy rattlers are aggressive and will strike anything within striking range.

Cottonmouth (Water Moccasin)

Young cottonmouths are often mistaken for copperheads because of their reddish-brown crossbands. As these snakes age, their cross bands darken until they become almost solid black. Cottonmouths live near water sources like lakes, streams, rivers, ponds, and swamps. When threatened, cottonmouths may coil and open their mouths as though ready to bite. The white inside of the mouth is what gives this snake its name, "cottonmouth".

Copperhead

Copperheads have dark coppery red-brown hourglass crossbands on a lighter brown color. The top of the head is covered with large plate-like scales. Copperheads have cat-like eyes and a pit between their nostril and eye. These snakes live in rocky, wooded areas and low, wet swampy areas. Copperheads are sluggish and rarely bite, unless stepped on or touched.

Coral Snake

The body of this snake is ringed with black, yellow and red bands. (Remember: Red on yellow can kill a fellow. Red on black, venom lack.) The head of a coral snake is black, while the tail is black and yellow.

3.6.4 Venomous Insects

Common examples include bees, fire ants and wasps. Avoid contact with insects and their hives. If stung, remove the stinger by gently scraping it out of the skin (do not use tweezers). If the worker is stung by an insect, immediately apply an ice pack to the affected area and wash area with soap and water and apply antiseptic. If an allergic reaction occurs, contact emergency medical services for appropriate treatment. Seek medical attention immediately if you are allergic to venomous stings such as bees or if anaphylaxis symptoms are present.

3.6.5 Mosquitoes

Mosquitoes may transmit diseases such as West Nile Virus. Symptoms of West Nile Virus include: fever, headache, tiredness, body aches, and occasional rash. Avoid mosquito bites by wearing long sleeved shirt and long pants. Apply insect repellent to clothes and/or skin (if FDA approved for topical use). Report any dead birds in the area to local health officials. Mosquitoes are most active from dusk to dawn.

3.6.6 Fire Ants

Red and Black Fire Ants are capable of inflicting numerous stings (7 to 9) per ant in a matter of seconds, and large numbers of fire ants will typically attack at the same time. Fire ants are very aggressive and will sting simply upon coming in contact with skin. Individuals who are allergic to bees should carry bee sting kits when there is the potential to come in contact with fire ants. Fire ants are predominantly located in the southern United States.

The best way to avoid fire ants is to avoid disturbing their mounds. Fire ant mounds are typically constructed in disturbed habitats such as open fields, along roadsides, lawns, and many other open sunny areas. The mounds are constructed of dirt and/or other organic materials. Mounds are typically 10” to 24” in diameter and approximately 18” in height. If you disturb a mound, get away from the mound immediately.

Fire ant stings typically leave tiny red blisters and sometimes white pustules. Symptoms of stings include blistering, burning, swelling, pain, and irritation of the affected area. Recommended treatment consists of antihistamines along with topical antibiotic cream. Anaphylaxis symptoms such as shortness of breath, discomfort, lowered heart rate, etc. may also accompany fire ant stings. Seek medical attention immediately if you are allergic to venomous stings such as bees or if anaphylaxis symptoms are present.

3.6.7 Spiders/Scorpions

The black widow and brown recluse spiders are the most venomous. Avoid contact with spiders and scorpions and areas where they may hide. They favor dark hiding places. Inspect clothing and shoes before getting dressed. Wear gloves and safety shoes when working with lumber, rocks, inspecting buildings, etc. Signs and symptoms of bites include: headache, cramping pain/muscle rigidity, rash and/or itching, nausea, dizziness, vomiting, weakness or paralysis, and convulsions or shock. Wash bite area with soap and water and apply antibiotic cream. Contact emergency medical services if allergic reaction or severe symptoms occur.

3.6.8 Ticks

Deer ticks may carry and transmit Lyme disease to humans. Signs of Lyme disease include a reddish “bulls-eye” around the affected area approximately a week after the bite. Symptoms include headache, fever, and muscle/joint pain. Persons suspecting infection should contact a health professional. Whenever possible avoid areas likely to be infested with ticks during the spring and summer months.

Wear light-colored clothing so ticks can be easily spotted and removed. Wear long sleeves and pants and tuck pant legs into boots or socks. Apply insect repellents to clothing and skin (if FDA approved for topical application). Persons with long hair should tie their hair back to minimize the potential for ticks to nestle in the scalp.

Personnel should self perform tick checks once daily field work is completed. If a tick is embedded in the skin, use tweezers to grasp the tick’s head (near the skin) and pull straight out. Consider saving the removed tick for laboratory analysis.

3.6.9 Poisonous Plants

Common examples include poison ivy, poison oak and poison sumac. Avoid contact. Long-sleeved shirts and pants will allow some protection against inadvertent contact. If contact occurs, immediately wash the affected area thoroughly with soap and water. If an allergic reaction occurs, seek the care of a medical professional.

Poison Ivy is a trailing or climbing woody vine or a shrub-like plant with leaves that are each divided into three broad, pointed leaflets. The leaflets are commonly dark glossy green on top and slightly hairy underneath. They produce small yellowish or greenish flowers followed by berry-like drupes.



Poison Oak is a member of the same family as poison ivy and has a very similar appearance. Poison oak has leaves divided into three leaflets and generally has three to seven distinct lobes. Typically they are a shrubby type plant that can grow to eight feet in height, or sometimes can be a climbing plant.



The best way to prevent exposure is the ability to recognize these plants. Conduct an initial survey of the area to determine if the plants are present in the work area, and avoid contact with them.

If plants are located and work must be conducted in that area, have the plants removed if possible. If this is not possible, wear long sleeved shirts, gloves, and a heavy material type pants. Remember not to touch contaminated clothing. There are products available that can be applied to exposed skin, (similar to sunscreen products) prior to working around the plants. Tyvek suits may be another option used at the wearer's discretion to keep poisonous plant oils from getting on clothing. Please note that using Tyvek suits may increase the risk of heat stress conditions so extra precautions should be taken such as more frequent breaks and drinking plenty of fluids.

4. PERSONAL PROTECTIVE EQUIPMENT

The purpose of PPE is to protect employees from hazards and potential hazards they are likely to encounter during site activities. The amount and type of PPE used will be based on the nature of the hazard encountered or anticipated. Respiratory protection will be utilized when an airborne hazard has been identified using real-time air monitoring devices, or as a precautionary measure in areas designated by the RSUM or SSO.

Dermal protection, primarily in the form of chemical-resistant gloves and coveralls, will be worn whenever contact with chemically affected materials (e.g., soil, groundwater, sludge) is anticipated, without regard to the level of respiratory protection required.

On the basis of the hazards identified for this project, the following levels of personal protective equipment (PPE) will be required and used. Changes to the specified levels of PPE will not be made without the approval of the SSO after consultation with the RSUM.

4.1 Conditions Requiring Level D Protection

In general, site activities will commence in Level D PPE unless otherwise specified, or if the SSO determines on site that a higher level of PPE is required. Air monitoring of employee breathing zones will be routinely conducted using real-time air monitoring devices to determine if upgrading to Level C PPE is necessary. Level D PPE will be permitted as long as air monitoring data indicate that airborne concentrations of chemicals of concern are maintained below the site-specific action levels defined in Section 5.2. Level A or B PPE is not anticipated and is therefore not addressed in this plan. If Level A or B PPE is necessary, this HASP will be revised to reflect changes as appropriate.

It is important to note that dermal protection is required whenever contact with chemically-affected materials is anticipated. The following equipment is specified as the minimum PPE required to conduct activities at the Site:

- Work shirt and long pants,
- ANSI- or ASTM-approved steel-toed boots or safety shoes,
- ANSI-approved safety glasses, and
- ANSI-approved hard hat.

Other personal protection readily available for use, if necessary, includes the following items.

- Outer nitrile gloves (11 mil or thicker) and inner nitrile surgical gloves when direct contact with chemically affected soils or groundwater is anticipated (nitrile surgical gloves may be used for collecting or classifying samples as long as they are removed and disposed of immediately after each sampling event).
- Chemical-resistant clothing (e.g., Tyvek or polycoated Tyvek coveralls) when contact with chemically affected soils or groundwater is anticipated.

- Safety shoes/boots with protective overboots or knee-high PVC polyblend boots when direct contact with chemically affected soils is anticipated.
- Hearing protection.
- Sturdy work gloves.
- High-visibility traffic safety vest.

Work will cease and PPE upgraded if action levels specified in Section 5.2 are exceeded. The RSUM will be notified whenever PPE is upgraded or downgraded.

4.2 Conditions Requiring Level C Protection

If air monitoring indicates that the site-specific action levels defined in Section 5.2 are exceeded, workers in the affected area(s) will upgrade PPE to Level C. In addition to the protective equipment specified for Level D, Level C also includes the following items.

- NIOSH-approved half- or full-face air-purifying respirator (APR) equipped with appropriate cartridges (reference Section 5.2). Note: safety glasses are not required when wearing a full-face APR.
- Outer nitrile gloves (11 mil or thicker) and inner nitrile surgical gloves when direct contact with chemically affected soils or groundwater is anticipated (nitrile surgical gloves may be used for collecting or classifying samples as long as they are removed and disposed of immediately after each sampling event).
- Chemical-resistant clothing (e.g., Tyvek or polycoated Tyvek coveralls) when contact with chemically affected soils or groundwater is anticipated.
- Safety shoes/boots with protective overboots or knee-high PVC polyblend boots when direct contact with chemically affected soils is anticipated.
- Hearing protection.
- Sturdy work gloves.

Respirators will be stored in clean containers (i.e., self-sealing bag) when not in use. Respirator cartridges will be replaced in accordance with the following change-out schedule.

Type of Cartridge	Cartridge Change-out Schedule
Particulate (i.e., HEPA)	At least weekly or sooner the employee detects an increase in breathing resistance. This will occur as the filter becomes loaded with particulate matter.
Sorbent (i.e., organic vapor)	At the end of each day's use or sooner if the employee detects an abnormal odor or other indicator.

Personnel who wear air-purifying respirators must be trained in their use and must have successfully passed either a qualitative or quantitative respirator fit test, and medical evaluation within the last 12 months in accordance with and 29 CFR 1910.134.

4.3 Stop Work Conditions

If air monitoring indicates that the site-specific action levels defined in Section 5.2 are exceeded, activities will cease, and personnel must evacuate the designated Exclusion Zone. The PM and RSUM will be contacted immediately.

Work will also cease if unanticipated conditions or materials are encountered or if an imminent danger is identified. The SSO will immediately contact the RSUM for consultation.

HEALTH AND SAFETY PLAN

5. AIR MONITORING PLAN

Real-time air monitoring devices will be used to analyze airborne contaminant concentrations approximately every 15 minutes in the workers' breathing zones while workers are in the designated Exclusion Zone, or when task or exposure conditions change (whichever frequency is less). If elevated concentrations are indicated, the monitoring frequency will be increased, as appropriate.

Background concentrations will be determined at the beginning of each work shift by collecting several instrument readings upwind of the scheduled activities. Alternatively, background levels can be determined by collecting readings from a nearby (upwind) area that can reasonably be considered unaffected by Site activities.

Real-time measurements will be made as near as feasible to the breathing zone of the worker with the greatest exposure potential in each active work area. If authorized by the RSUM, real time measurements may cease being taken when enough historical data is generated to warrant its cessation. Air monitoring will be reinstated if potential exposure conditions change.

The equipment will be calibrated daily, and the results will be recorded on BC's Air Monitoring Form. The results of air monitoring will also be recorded on the Air Monitoring Form and will be retained in the project files following completion of field activities. A copy of the Air Monitoring Form is located in Appendix A.

5.1 Monitoring Instruments

On-site worker exposure to airborne contaminants will be monitored during intrusive site activities. A calibrated photoionization detector (PID) with a lamp strength of 10.6 eV or flame ionization detector (FID) will be used to monitor changes in personnel exposure to volatile organic compounds (VOCs). The SSO, or designee, will perform routine monitoring during site operations to evaluate concentrations of VOCs in employee breathing zones. If VOCs are detected above predetermined action levels specified in Section 5.2, the procedures found in Section 4 of this HASP will be followed.

5.2 Site Specific Action Levels

The following action levels were developed for exposure monitoring with real-time air monitoring instruments. Air monitoring data will determine the required respiratory protection levels at the Site during scheduled intrusive activities. The action levels are based on sustained readings indicated by the instrument(s). Air monitoring will be performed and recorded at up to 15-minute intervals.

If elevated concentrations are indicated, the monitoring frequency will be increased, as appropriate. If during this time, sustained measurements are observed, the following actions will be instituted, and the PM and RSUM will be notified. For purposes of this HASP, sustained readings are defined as the average airborne concentration maintained for a period of one (1) minute above established background levels.

Dust – no monitoring based on activities

Soil coring or the installation of geoprobes in areas of known or probable soil impact will require engineering controls to ensure that dust generation does not occur. The SSO will be responsible for monitoring the conditions of excavations and soil piles generated from excavations to ensure that dust conditions do not develop. The contractor responsible for the excavation will have means present at all times to keep the soil moist, and will implement this engineering control if dust generation or the potential for dust generation is present. The Site SSO will monitor conditions and verify that the contractor is properly implementing the dust control measure(s). Engineering controls will generally involve wetting the soil and/or excavation, but could involve other control measures as needed. If the SSO notes dry soil conditions associated with impacted soil excavations or stockpiles, work will be stopped and will not resume until the engineering controls are in place. If it is found that engineering controls are not effective for dust control and monitoring is needed to ensure the safety of site workers, the SSO will contact the RSUM and PM immediately and Action Levels will be established by the RSUM. Work will not resume until an approved monitoring method is in place to ensure worker safety.

VOCs

Activity	Action Level	Level of Respiratory Protection
TYPE OF ACTIVITIES	< 5 ppm above background (VOCs)	Level D: No respiratory protection required.
	5 to 10 ppm (VOCs)	<p>Increase engineering controls to reduce potential employee exposure to VOCs and re-monitor:</p> <ul style="list-style-type: none">▪ If VOC levels <u>don't exceed</u> the first Action Limit - Use: Level D▪ If VOC levels <u>exceed</u> the first Action Limit - Use Level C (half-or full-face air-purifying respirator fitted with organic vapor filter cartridges) <p>Contact RSUM prior to respirator upgrade.</p>
	> 10 ppm (VOCs)	Cease operations and evacuate work area. Contact RSUM and PM immediately.

HEALTH AND SAFETY PLAN

6. SITE CONTROL MEASURES

The SSO will conduct a safety inspection of the work site before each day's activities begin to verify compliance with the requirements of the HASP. Results of the first day's inspection will be documented on the Site Safety Checklist. A copy of the checklist is included in Appendix B. Thereafter, the SSO should document unsafe conditions or acts, along with corrective action, in the project field log book.

Procedures must be followed to maintain site control so that persons who may be unaware of site conditions are not exposed to hazards. The work area will be barricaded by tape, warning signs, or other appropriate means. Site equipment or machinery will be secured and stored safely.

Access to the specified work area will be limited to authorized personnel. Only BC employees and designated BC subcontracted personnel, as well as designated employees of the client, will be admitted to the work site. Personnel entering the work area are required to sign the signature page of this HASP, indicating they have read and accepted the health and safety practices outlined in this plan.

In some instances it may be necessary to define established work zones: an Exclusion Zone, a Contamination Reduction Zone, and a Support Zone. Work zones may be established based on the extent of anticipated contamination, projected work activities, and the presence or absence of non-project personnel. The physical dimensions and applicability of work zones will be determined for each area based on the nature of job activity and hazards present. Within these zones, prescribed operations will commence using appropriate PPE. Movement between zones will be controlled at checkpoints.

Considerable judgment is needed to maintain a safe working area for each zone, balanced against practical work considerations. Physical and topographical barriers may constrain ideal locations. Field measurements combined with climatic conditions may, in part, determine the control zone distances. Even when work is performed in an area that does not require the use of chemical-resistant clothing, work zone procedures may still be necessary to limit the movement of personnel and retain adequate site control.

Personnel entering the designated Exclusion Zone should exit at the same location. There must be an alternate exit established for emergency situations. In all instances, worker safety will take precedence over decontamination procedures. If decontamination of personnel is necessary, exiting the Site will include the decontamination procedures described in the following section.

7. DECONTAMINATION PROCEDURES

Decontamination will take place in the decontamination area identified on-Site. Workers, PPE, sampling equipment, and heavy equipment leaving the exclusion area will be inspected to determine the level of decontamination necessary to prevent the spread of potentially hazardous materials. Unnecessary equipment and support vehicles are to be left outside the designated Exclusion Zone so that decontamination will not be necessary.

Despite protective procedures, personnel may come in contact with potentially hazardous compounds while performing work tasks. If so, decontamination needs to take place using an Alconox or TSP wash, followed by a rinse with clean water. Standard decontamination procedures for levels C and D are as follows.

- equipment drop,
- boot cover and outer glove wash and rinse,
- boot cover and outer glove removal,
- suit removal,
- safety boot wash and rinse,
- inner glove wash and rinse,
- respirator removal,
- inner glove removal, and
- field wash of hands and face.

Site workers should employ only applicable steps in accordance with level of PPE worn and extent of contamination present. The SSO shall maintain adequate quantities of clean water to be used for personal decontamination (i.e., field wash of hands and face) whenever a suitable washing facility is not located in the immediate vicinity of the work area.

Disposable items will be disposed of in an appropriate container. Wash and rinse water generated from decontamination activities will be handled and disposed of properly. Non-disposable items (i.e., respirators) may need to be cleaned or sanitized before reuse. Each site worker is responsible for the maintenance, decontamination, and sanitizing of their own PPE.

Used equipment may be decontaminated as follows.

- Remove adhered materials (i.e., dirt or mud) to increase the effectiveness of the decontamination process.
- An Alconox or TSP and water solution may be used to wash the equipment.
- The equipment will then be rinsed with clean water until it is determined clean.

Each person must follow these procedures to reduce the potential for transferring chemically affected materials off site.

8. TRAINING REQUIREMENTS

BC Site personnel, including subcontractors and visitors conducting work in controlled areas of the Site, must have completed the appropriate training as required by 29 CFR 1910.120. In addition, the SSO will have completed the 8-hour Site Supervisor course, have current training in first aid and CPR, and any additional training appropriate to the level of site hazards. Further site-specific training will be conducted by the SSO prior to the initiation of project activities. This training will include, but will not necessarily be limited to, emergency procedures, site control, personnel responsibilities, and the provisions of this HASP. Each employee will document that they have been briefed on the hazards identified at the site and that they have read and understand the requirements of this HASP by signing the H&S Plan Acknowledgement Form attached as Appendix C.

A daily morning briefing to cover safety procedures and contingency plans in the event of an emergency is to be included with a discussion of the day's activities. These daily meetings will be recorded on the Daily Tailgate Safety Meeting Form. A copy of the Daily Tailgate Safety Meeting Form is included in Appendix D.

9. MEDICAL SURVEILLANCE REQUIREMENTS

BC Site personnel, including subcontractors and site visitors, who will or may work in an area designated as an exclusion zone must have fulfilled the appropriate medical monitoring requirements in accordance with 29 CFR 1910.120(f). Each individual entering an exclusion zone must have successfully completed an annual surveillance examination and/or an initial baseline examination within the last 12 months.

Medical surveillance is conducted as a routine program for BC field staff in accordance with the requirements of 29 CFR 1910.120(f). There will not be any special medical tests or examinations required for staff involved in this project.

A Hepatitis B vaccination will be offered to BC personnel before the person participates in a task where direct exposure to potentially infectious materials is a possibility (i.e., first aid or CPR). For personnel who have potential exposure to sanitary wastes, a current tetanus/diphtheria inoculation or booster is recommended.

HEALTH AND SAFETY PLAN

10. CONTINGENCY PROCEDURES

Minimum emergency equipment maintained on site will include a fully charged ABC dry chemical fire extinguisher, an adequately stocked first aid kit, and an emergency eyewash station (when corrosive chemicals are present). In addition, employees will consider maintaining the personal emergency supply items listed in Section 3: Natural Phenomena, as appropriate.

In the event of an emergency, site personnel will signal distress with three blasts of a horn (a vehicle horn will be sufficient), or other predetermined signal. Communication signals, such as hand signals, must be established where communication equipment is not feasible or in areas of loud noise.

It is the SSO's duty to evaluate the seriousness of the situation and to notify appropriate authorities. The first part of this plan contains emergency telephone numbers as well as directions to the hospital. Nearby telephone access must be identified and available to communicate with local authorities. If a nearby telephone is not available, a cellular telephone will be maintained on site during work activities. The operation of the cellular phone will be verified to ensure that a signal can be achieved at the work location.

The SSO, or designee, should contact local emergency services in the event of an emergency. After emergency services are notified, the PM and RSUM will be notified of the situation as soon as possible. If personal injury, property damage or equipment damage occurs, the PM and BC Risk Manager will be contacted as soon as practicable. An Accident/Incident Investigation Report will be completed within 24 hours by the SSO, or other designated person. A copy of the Accident/Incident Investigation Report is included in Appendix E.

MSHA Immediate Notification Rule:

At projects conducted at mining facilities, incident reporting requirements differ from OSHA standards. Site-specific MSHA reporting requirements must be addressed in conjunction with the RSUM and PM.

In order to comply with the MSHA Immediate Notification rule (50.10), Brown and Caldwell has developed the 'MSHA Immediately Reportable Accident/Injury Notification Procedure'. Note that incidents meeting the definition of "immediately reportable" must be reported to MSHA within 15 minutes of occurrence.

http://search.bc.com/health_safety/documents/BC_MSHANotificationProcedure.doc

This new procedure can be accessed by clicking the link above and includes a decision flowchart and accompanying instructions to help guide field personnel in the event of a reportable accident/injury at a mining site.

10.1 Injury or Illness

If an exposure or injury occurs, work will be temporarily halted until an assessment can be made to determine it is safe to continue work. The SSO, in consultation with the RSUM, will make the decision regarding the safety of continuing work. The SSO will conduct an investigation to determine the cause of the incident and steps to be taken to prevent recurrence.

In the event of an injury, the extent and nature of the victim's injuries will be assessed and first aid/CPR will be rendered as appropriate. If necessary, emergency services will be contacted or the individual may be transported to the nearby medical center. The mode of transportation and the eventual destination will be based on the nature and extent of the injury. A hospital route map is presented at the front of this HASP.

In the event of a life-threatening emergency, the injured person will be given immediate first aid and emergency medical services will be contacted by dialing the number listed in the Critical Project Information section at the beginning of this plan. The individual rendering first aid will follow directions given by emergency medical personnel via telephone.

10.2 Vehicle Collision or Property Damage

If a vehicle collision or property damage event occurs, the SSO, or designee, will contact the BC Risk Manager for appropriate action.

10.3 Fire

In the event of fire, the alarm will be sounded and Site personnel will evacuate to a safe location (preferably upwind). The SSO, or designee, should contact the local fire department immediately by dialing 911. When the fire department arrives, the SSO, or designated representative, will advise the commanding officer of the location and nature of the fire nature, and identification of hazardous materials on site. Only trained, experienced fire fighters should attempt to extinguish substantial fires at the Site. Site personnel should not attempt to fight fires, unless properly trained and equipped to do so. Site personnel should not attempt to fight a fire if it poses a risk to their personal safety.

Note that smoking is not permitted in controlled areas (i.e., exclusion or contamination reduction zones), near flammable or combustible materials, or in areas designated by the facility as non-smoking areas.

10.4 Underground Utilities

In the event that an underground conduit is damaged during subsurface work, mechanized equipment will immediately be shut off and personnel will evacuate the area until the nature of the piping can be determined. Depending on the nature of the broken conduit (e.g., natural gas, water, or electricity), the appropriate local utility will be contacted.

10.5 Site Evacuation

The SSO will designate evacuation routes and refuge areas to be used in the event of a Site emergency. Site personnel will stay upwind from vapors or smoke and upgradient from spills. If workers are in an Exclusion or Contamination Reduction Zone at the start of an emergency, they should exit through the established decontamination corridors, if possible. If evacuation cannot be done through an established decontamination area, site personnel will go to the nearest safe location and remove chemically-affected clothing there or, if possible, leave it near the Exclusion Zone. Personnel will assemble at the predetermined refuge following evacuation and decontamination. The SSO, or designated representative, will count and identify site personnel to verify that all have been evacuated safely.

10.6 Spill of Hazardous Materials

If a hazardous material spill occurs, site personnel should locate the source of the spill and determine the hazard to the health and safety of site workers and the public. Attempts to stop or reduce the flow should only be performed if it can be done without risk to personnel.

Isolate the spill area and do not allow entry by unauthorized personnel. De-energize sources of ignition within 100 feet of the spill, including vehicle engines. Should a spill be of the nature or extent that it cannot be safely contained, or poses an imminent threat to human health or the environment, an emergency cleanup contractor will be called out as soon as possible. Spill containment measures listed below are examples of responses to spills.

- Right or rotate containers to stop the flow of liquids. This step may be accomplished as soon as the spill or leak occurs, providing it is safe to do so.
- Sorbent pads, booms, or adjacent soil may be used to dike or berm materials, subject to flow, and to solidify liquids.
- Sorbent pads, soil, or booms, if used, must be placed in appropriate containers after use, pending disposal.
- Contaminated tools and equipment shall be collected for subsequent cleaning or disposal.

11. DOCUMENTATION

The implementation of the HASP must be documented on the appropriate forms (see appendices) to verify employee participation and protection. In addition, the regulatory requirements must be met for recordkeeping on training, medical surveillance, injuries and illnesses, exposure monitoring, health risk information, and respirator fit-tests. Documentation of each BC employee's health and safety records is maintained by the Health and Safety Data Manager in Walnut Creek, California.

Health and safety documentation and forms completed, as specified by this plan, are to be retained in the project file.

Other relevant project-specific health and safety documents, such as MSDSs or client-specified procedures, will be attached to this HASP in Appendix F.

APPENDIX A

Air Monitoring Form

[illegible]

Site Safety Checklist

H&S Plan Acknowledgement Form

Instructions: Complete this form immediately prior to project start or as new personnel join the project.

Name of Project/Site:			Project No:		
Project/Site Location:					
Employee Performing Briefing: (Print and Sign):				Date:	
<p style="text-align: center;">Employee Acknowledgement:</p> <p style="text-align: center;">The following signatures indicate that these personnel have read and/or been briefed on this Health and Safety (H&S) Plan and understand the potential hazards/controls for the work to be performed.</p> <p style="text-align: center;">Important Notice to Subcontractor(s):</p> <p>Subcontractors are responsible for developing, maintaining, and implementing their own health and safety programs, policies, procedures and equipment as necessary to protect their workers, and others, from their activities. Subcontractors shall operate equipment in accordance with their standard operating procedures as well as manufacturer's specifications. Any project monitoring activities conducted by BC at the Site shall not in any way relieve subcontractors of their critical obligation to monitor their operations and employees for the determination of exposure to hazards that may be present at the Site and to provide required guidance and protection. If requested, subcontractors will provide BC with a copy of their own H&S Plan for this project or other health and safety program documents for review.</p> <p>BC's Health and Safety Plan has been prepared specifically for this project and is intended to address health and safety issues solely with respect to the activities of BC's own employees at the site. A copy of BC's H&S Plan may be provided to subcontractors in an effort to help them identify expected conditions at the site and general site hazards. The subcontractor shall remain responsible for identifying and evaluating hazards at the site as they pertain to their activities and for taking appropriate precautions. For example, BC's H&S Plan does not address specific hazards associated with tasks and equipment that are particular to the subcontractor's scope of work and site activities. (e.g., operation of a drill rig, excavator, crane or other equipment). Subcontractors are not to rely on BC's H&S Plan to identify all hazards that may be present at the Site. Subcontractor personnel are expected to comply fully with subcontractor's Health and Safety Plan and to observe the minimum safety guidelines applicable to their activities which may be identified in the BC H&S Plan. Failure to do so may result in the removal of the subcontractor or any of the subcontractor's workers from the job site.</p>					
Print	Sign	Date	Print	Sign	Date

Daily Tailgate Meeting Form

Name of Project/Site:	Project No:																																																
Project/Site Location:																																																	
Employee Completing Form: (Print and Sign):	Date:																																																
<p style="text-align: center;">Employee Acknowledgement:</p> <p style="text-align: center;">The following signatures indicate that these personnel have read and/or been briefed on this Health and Safety (H&S) Plan and understand the potential hazards/controls for the work to be performed.</p> <p style="text-align: center;">Important Notice to Subcontractor(s):</p> <p>Subcontractors are responsible for developing, maintaining, and implementing their own health and safety programs, policies, procedures and equipment as necessary to protect their workers, and others, from their activities. Subcontractors shall operate equipment in accordance with their standard operating procedures as well as manufacturer's specifications. Any project monitoring activities conducted by BC at the Site shall not in any way relieve subcontractors of their critical obligation to monitor their operations and employees for the determination of exposure to hazards that may be present at the Site and to provide required guidance and protection. If requested, subcontractors will provide BC with a copy of their own H&S Plan for this project or other health and safety program documents for review.</p> <p>BC's Health and Safety Plan has been prepared specifically for this project and is intended to address health and safety issues solely with respect to the activities of BC's own employees at the site. A copy of BC's H&S Plan may be provided to subcontractors in an effort to help them identify expected conditions at the site and general site hazards. The subcontractor shall remain responsible for identifying and evaluating hazards at the site as they pertain to their activities and for taking appropriate precautions. For example, BC's H&S Plan does not address specific hazards associated with tasks and equipment that are particular to the subcontractor's scope of work and site activities. (e.g., operation of a drill rig, excavator, crane or other equipment). Subcontractors are not to rely on BC's H&S Plan to identify all hazards that may be present at the Site. Subcontractor personnel are expected to comply fully with subcontractor's Health and Safety Plan and to observe the minimum safety guidelines applicable to their activities which may be identified in the BC H&S Plan. Failure to do so may result in the removal of the subcontractor or any of the subcontractor's workers from the job site.</p>																																																	
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<p style="text-align: center;">Plan of the Day</p> <p style="text-align: center;">(Describe the activities that are planned to be performed today)</p> <div style="border: 1px solid black; height: 40px; margin-top: 5px;"></div> <div style="border: 1px solid black; height: 40px; margin-top: 5px;"></div> <div style="border: 1px solid black; height: 40px; margin-top: 5px;"></div>																																																	
<p style="text-align: center;">Potential Hazards and Topics Discussed</p> <p style="text-align: center;">(Describe the potential hazards and controls that may be associated with planned activities)</p> <div style="border: 1px solid black; padding: 5px; margin-top: 5px;"><input type="checkbox"/> Electrical <input type="checkbox"/> Chemical <input type="checkbox"/> Biological <input type="checkbox"/> Physical <input type="checkbox"/> Other (specify):</div> <div style="border: 1px solid black; height: 40px; margin-top: 5px;"></div> <div style="border: 1px solid black; height: 40px; margin-top: 5px;"></div> <div style="border: 1px solid black; height: 40px; margin-top: 5px;"></div> <div style="border: 1px solid black; height: 40px; margin-top: 5px;"></div> <div style="border: 1px solid black; height: 40px; margin-top: 5px;"></div> <div style="border: 1px solid black; height: 40px; margin-top: 5px;"></div> <div style="border: 1px solid black; height: 40px; margin-top: 5px;"></div>																																																	

Incident Investigation Report

Instructions:

If an accident or incident occurs, complete all applicable information in this form, make a copy for your records, and immediately forward the original to the office Health and Safety Coordinator (HSC). If fields are not applicable, indicate with "N/A". Use separate sheet(s) if necessary and attach sketches, photographs, or other information that may be helpful in understanding how the accident/incident occurred.

HSC – Review and enter report into the BC Online Safety Observation and Incident Reporting System within 3 workdays of receipt. File original in appropriate office health and safety file.

NOTE:

This report is important – please take the time necessary to properly complete it. Incomplete reports will be forwarded to appropriate management for review and action.

General Information

Date of Accident/Incident	Time of Accident/Incident:	Date Accident/Incident Reported:	To Whom:
Exact Location of Accident/Incident (Street, City, State):			BC Office:
Name Project:			Project Number:
Employee Completing the Investigation (Print and Sign):			Date:

Injured/Ill Employee/Property Damage Information

Employee Name:	Employee No.	Department:	Phone Number:
Job Title:		Manager's Name and Phone Number:	
Nature of Injury/Illness (laceration, contusion, strain, etc.):		Body Part Affected (arm, leg, head, hand, etc.):	
Describe Property Damage and Estimate Loss :			

Description of Accident/Incident

Describe the accident sequentially, beginning with the initiating event, and followed by secondary and tertiary events. End with the nature and extent of injury/damage. Name any object or substance and tell how they were included. Examples: 1) Employee was pulling utility cart that was loaded with wastepaper from office area to hallway. Wheel of utility cart caught against door casing. Bags of heavy wastepaper that were in cart fell to end of cart. Cart tipped over onto foot of employee. Right foot was crushed between utility cart and door casing, resulting in severe contusion to right foot of employee. 2) Employee was driving rental car from office to project site. Car struck icy section of road. Employee lost control of vehicle, which skidded across road into concrete abutment on side of road. Accident resulted in damage to right fender, tire, headlight, and grill.

Analysis of Accident Causes**Immediate Causes - Substandard Actions**

What substandard actions caused or could have caused the accident/incident? State the actions on the part of the employee or others that contributed to the occurrence of the accident/incident. Examples: 1) Employee overloaded the utility cart with wastepaper. 2) Employee exceeded safe speed on icy road, and was inattentive to hazard.

Codes (check all that apply)

- | | | | |
|---|--|---|---|
| <input type="checkbox"/> 1. Operating equipment without authority | <input type="checkbox"/> 5. Making safety devices inoperable | <input type="checkbox"/> 9. Failure to use PPE properly | <input type="checkbox"/> 13. Improper position for task |
| <input type="checkbox"/> 2. Failure to warn | <input type="checkbox"/> 6. Removing safety devices | <input type="checkbox"/> 10. Improper loading | <input type="checkbox"/> 14. Servicing equipment in operation |
| <input type="checkbox"/> 3. Failure to secure | <input type="checkbox"/> 7. Using defective equipment | <input type="checkbox"/> 11. Improper placement | <input type="checkbox"/> 15. Horseplay |
| <input type="checkbox"/> 4. Operating at improper speed | <input type="checkbox"/> 8. Using equipment improperly | <input type="checkbox"/> 12. Improper lifting | <input type="checkbox"/> 16. Alcohol or drug influence |
| <input type="checkbox"/> 17. Other (specify) | | | |

Immediate Causes - Substandard Conditions

What substandard conditions caused or could have caused the accident/incident? State the conditions that existed at the time of the accident (the specific control factors that were or may have been the direct or immediate cause or causes of the accident). Examples: 1) Wheel of utility cart was worn and would not roll properly; utility cart was overloaded with wastepaper. 2) Road was covered with icy spots; weather was foggy.

Codes (check all that apply)

- | | | | |
|--|---|---|--|
| <input type="checkbox"/> 1. Inadequate guards or barriers | <input type="checkbox"/> 4. Congestion or restricted action | <input type="checkbox"/> 7. Poor housekeeping | <input type="checkbox"/> 10. High or low temperature exposures |
| <input type="checkbox"/> 2. Inadequate or improper PPE | <input type="checkbox"/> 5. Inadequate earning system | <input type="checkbox"/> 8. Noise exposures | <input type="checkbox"/> 11. Inadequate or excess illumination |
| <input type="checkbox"/> 3. Defective tools, equipment, or materials | <input type="checkbox"/> 6. Fire and explosion hazards | <input type="checkbox"/> 9. Radiation exposures | <input type="checkbox"/> 12. Inadequate ventilation |
| <input type="checkbox"/> 13. Hazardous environ. conditions (vapors, dusts, etc.) | | | |
| <input type="checkbox"/> 14. Other (specify) | | | |

Basic Causes - Personal and Job Factors

What personal and/or job factors caused or could have caused the accident/incident? State the influencing factors or underlying causes, either conditions or actions or both, that contributed to the accident/incident. Examples: 1) Employee had not been instructed in overloading hazards. 2) Employee had not been trained in driving under winter conditions; company has no driver training program.

Codes (check all that apply)**Personal Factors**

- ☐ 1. Inadequate capability ☐ 2. Lack of knowledge ☐ 3. Lack of skill ☐ 4. Improper motivation
☐ 5. Other (specify): _____

Job Factors

- ☐ 1. Inadequate leadership/supervision ☐ 2. Inadequate engineering ☐ 3. Inadequate purchasing ☐ 4. Inadequate maintenance ☐ 5. Inadequate tools/equipment
☐ 6. Inadequate work standards/procedures ☐ 7. Inadequate Wear and tear ☐ 8. Abuse or misuse
☐ 9. Other (specify): _____

Remedial Actions

Describe the actions taken or planned to prevent recurrence of accident/incident - provide the implementation date and person responsible for any planned corrective action.. Examples: 1) Wheels of utility cart were replaced with larger size wheels; all carts were inspected for safe operation; employees were instructed in overloading hazards. 2) All project personnel were instructed at the safety training meeting on driving under hazardous conditions; driver training program will be implemented.

Codes (check all that apply)**Job Factors**

- ☐ 1. Reinstruction of personnel involved ☐ 2. Reprimand of personnel involved ☐ 3. Temporary/permanent reassignment of personnel ☐ 4. Action to improve clean-up
☐ 5. Equipment repair or replacement ☐ 6. Improve design ☐ 7. Improve construction ☐ 8. Improve PPE ☐ 9. Install of safety guard or device ☐ 10. Work method change
☐ 11. Order use of safer materials ☐ 12. Regional Safety Unit Manager Review
☐ 13. Other (specify): _____

Miscellaneous Health and Safety Information

Appendix D: Laboratory Analytical Reports

ANALYTICAL REPORT

REVISED

PROJECT NO. 139452

CRS-ELYRIA, OH

Lot #: A0I270433

James A. Peeples

Brown and Caldwell
4700 Lakehurst Court
Suite 100
Dublin, OH 43016

TESTAMERICA LABORATORIES, INC.


Designee for

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Approved for release.
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11/4/2010 2:20 PM

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CASE NARRATIVE

A0I270433

The following report contains the analytical results for five water samples and one quality control sample submitted to TestAmerica North Canton by Brown & Caldwell from the CRS-ELYRIA, OH Site, project number 139452. The samples were received September 27, 2010, according to documented sample acceptance procedures.

This report was revised. Per the client, the first number of sample date looks like "7" on original COC, but is actually supposed to be a "9". All sample dates should be 9/23/10, not 7/23/10. The dates in this report have been updated accordingly.

TestAmerica utilizes USEPA approved methods in all analytical work. The samples presented in this report were analyzed for the parameter(s) listed on the analytical methods summary page in accordance with the method(s) indicated. Preliminary results were provided to James A. Peeples on October 11, 2010. A summary of QC data for these analyses is included at the back of the report.

TestAmerica North Canton attests to the validity of the laboratory data generated by TestAmerica facilities reported herein. All analyses performed by TestAmerica facilities were done using established laboratory SOPs that incorporate QA/QC procedures described in the applicable methods. TestAmerica's operations groups have reviewed the data for compliance with the laboratory QA/QC plan, and data have been found to be compliant with laboratory protocols unless otherwise noted below.

The test results in this report meet all NELAP requirements for parameters for which accreditation is required or available. Any exceptions to NELAP requirements are noted in this report. Pursuant to NELAP, this report may not be reproduced, except in full, without the written approval of the laboratory.

All parameters were evaluated to the method detection limit and include qualified results where applicable.

Please refer to the Quality Control Elements Narrative following this case narrative for additional quality control information.

If you have any questions, please call the Project Manager, Alesia M. Danford, at 330-497-9396.

This report is sequentially paginated. The final page of the report is labeled as "END OF REPORT."

CASE NARRATIVE (continued)

SUPPLEMENTAL QC INFORMATION

SAMPLE RECEIVING

The temperature of the cooler upon sample receipt was 3.4°C.

See TestAmerica's Cooler Receipt Form for additional information.

GC/MS VOLATILES

The sample(s) that contained concentrations of target analyte(s) at a reportable level in the associated Method Blank(s) were flagged with "B". All target analytes in the Method Blank must be below the reporting limit (RL) or the associated sample(s) must be ND with the exception of common laboratory contaminants.

The sample(s) that contain results between the MDL and the RL were flagged with "J". There is a possibility of false positive or mis-identification at these quantitation levels. In analytical methods requiring confirmation of the analyte reported, confirmation was performed only down to the standard reporting limit (SRL). The acceptance criteria for QC samples may not be met at these quantitation levels.

QUALITY CONTROL ELEMENTS NARRATIVE

TestAmerica conducts a quality assurance/quality control (QA/QC) program designed to provide scientifically valid and legally defensible data. Toward this end, several types of quality control indicators are incorporated into the QA/QC program, which is described in detail in QA Policy, QA-003. These indicators are introduced into the sample testing process to provide a mechanism for the assessment of the analytical data. Program or agency specific requirements take precedence over the requirements listed in this narrative.

QC BATCH

Environmental samples are taken through the testing process in groups called QUALITY CONTROL BATCHES (QC batches). A QC batch contains up to twenty environmental samples of a similar matrix (water, soil) that are processed using the same reagents and standards. TestAmerica North Canton requires that each environmental sample be associated with a QC batch.

Several quality control samples are included in each QC batch and are processed identically to the twenty environmental samples.

For SW846/RCRA methods, QC samples include a METHOD BLANK (MB), a LABORATORY CONTROL SAMPLE (LCS) and, where appropriate, a MATRIX SPIKE/MATRIX SPIKE DUPLICATE (MS/MSD) pair or a MATRIX SPIKE/SAMPLE DUPLICATE (MS/DU) pair. If there is insufficient sample to perform an MS/MSD or an MS/DU, then a LABORATORY CONTROL SAMPLE DUPLICATE (LCSD) is included in the QC batch.

For 600 series/CWA methods, QC samples include a METHOD BLANK (MB), a LABORATORY CONTROL SAMPLE (LCS) and, where appropriate, a MATRIX SPIKE (MS). An MS is prepared and analyzed at a 10% frequency for GC Methods and at a 5% frequency for GC/MS methods.

LABORATORY CONTROL SAMPLE

The Laboratory Control Sample is a QC sample that is created by adding known concentrations of a full or partial set of target analytes to a matrix similar to that of the environmental samples in the QC batch. Multi peak responders may not be included in the target spike list due to co-elution. The LCS analyte recovery results are used to monitor the analytical process and provide evidence that the laboratory is performing the method within acceptable guidelines. All control analytes indicated by a bold type in the LCS must meet acceptance criteria. Failure to meet the established recovery guidelines requires the reparation and reanalysis of all samples in the QC batch. Comparison of only the failed parameters from the first batch are evaluated. The only exception to the rework requirement is that if the LCS recoveries are biased high and the associated sample is ND (non-detected) for the parameter(s) of interest, the batch is acceptable.

At times, a Laboratory Control Sample Duplicate (LCSD) is also included in the QC batch. An LCSD is a QC sample that is created and handled identically to the LCS. Analyte recovery data from the LCSD is assessed in the same way as that of the LCS. The LCSD recoveries, together with the LCS recoveries, are used to determine the reproducibility (precision) of the analytical system. Precision data are expressed as relative percent differences (RPDs). If the RPD fails for an LCS/LCSD and yet the recoveries are within acceptance criteria, the batch is still acceptable.

METHOD BLANK

The Method Blank is a QC sample consisting of all the reagents used in analyzing the environmental samples contained in the QC batch. Method Blank results are used to determine if interference or contamination in the analytical system could lead to the reporting of false positive data or elevated analyte concentrations. All target analytes must be below the reporting limits (RL) or the associated sample(s) must be ND except under the following circumstances:

- Common organic contaminants may be present at concentrations up to 5 times the reporting limits. Common metals contaminants may be present at concentrations up to 2 times the reporting limit, or the reported blank concentration must be twenty fold less than the concentration reported in the associated environmental samples. (See common laboratory contaminants listed in the table.)

<u>Volatile (GC or GC/MS)</u>	<u>Semivolatile (GC/MS)</u>	<u>Metals ICP-MS</u>	<u>Metals ICP Trace</u>
Methylene Chloride, Acetone, 2-Butanone	Phthalate Esters	Copper, Iron, Zinc, Lead, Calcium, Magnesium, Potassium, Sodium, Barium, Chromium, Manganese	Copper, Iron, Zinc, Lead

QUALITY CONTROL ELEMENTS NARRATIVE (continued)

- Organic blanks will be accepted if compounds detected in the blank are present in the associated samples at levels 10 times the blank level. Inorganic blanks will be accepted if elements detected in the blank are present in the associated samples at 20 times the blank level.
- Blanks will be accepted if the compounds/elements detected are not present in any of the associated environmental samples.

Failure to meet these Method Blank criteria requires the reparation and reanalysis of all samples in the QC batch.

MATRIX SPIKE/MATRIX SPIKE DUPLICATE

A Matrix Spike and a Matrix Spike Duplicate are a pair of environmental samples to which known concentrations of a full or partial set of target analytes are added. The MS/MSD results are determined in the same manner as the results of the environmental sample used to prepare the MS/MSD. The analyte recoveries and the relative percent differences (RPDs) of the recoveries are calculated and used to evaluate the effect of the sample matrix on the analytical results. Due to the potential variability of the matrix of each sample, the MS/MSD results may not have an immediate bearing on any samples except the one spiked; therefore, the associated batch MS/MSD may not reflect the same compounds as the samples contained in the analytical report. When these MS/MSD results fail to meet acceptance criteria, the data is evaluated. If the LCS is within acceptance criteria, the batch is considered acceptable.

For certain methods, a Matrix Spike/Sample Duplicate (MS/DU) may be included in the QC batch in place of the MS/MSD. For the parameters (i.e. pH, ignitability) where it is not possible to prepare a spiked sample, a Sample Duplicate may be included in the QC batch. However, a Sample Duplicate is less likely to provide usable precision statistics depending on the likelihood of finding concentrations below the standard reporting limit. When the Sample Duplicate result fails to meet acceptance criteria, the data is evaluated.

For certain methods (600 series methods/CWA), a Matrix Spike is required in place of a Matrix Spike/Matrix Spike Duplicate (MS/MSD) or Matrix Spike/Sample Duplicate (MS/DU).

The acceptance criteria do not apply to samples that are diluted.

SURROGATE COMPOUNDS

In addition to these batch-related QC indicators, each organic environmental and QC sample is spiked with surrogate compounds. Surrogates are organic chemicals that behave similarly to the analytes of interest and that are rarely present in the environment. Surrogate recoveries are used to monitor the individual performance of a sample in the analytical system.

If surrogate recoveries are biased high in the LCS, LCSD, or the Method Blank, and the associated sample(s) are ND, the batch is acceptable. Otherwise, if the LCS, LCSD, or Method Blank surrogate(s) fail to meet recovery criteria, the entire sample batch is reprepared and reanalyzed. If the surrogate recoveries are outside criteria for environmental samples, the samples will be reprepared and reanalyzed unless there is objective evidence of matrix interference or if the sample dilution is greater than the threshold outlined in the associated method SOP.

The acceptance criteria do not apply to samples that are diluted. All other surrogate recoveries will be reported.

For the GC/MS BNA methods, the surrogate criterion is that two of the three surrogates for each fraction must meet acceptance criteria. The third surrogate must have a recovery of ten percent or greater.

For the Pesticide and PCB methods, the surrogate criterion is that one of two surrogate compounds must meet acceptance criteria. The second surrogate must have a recovery of 10% or greater.



TestAmerica Certifications and Approvals:

The laboratory is certified for the analytes listed on the documents below. These are available upon request.
California (#01144CA), Connecticut (#PH-0590), Florida (#E87225),
Illinois (#200004), Kansas (#E10336), Minnesota (#39-999-348), New Jersey (#OH001), New York (#10975), Nevada
(#OH-000482008A), OhioVAP (#CL0024), Pennsylvania (#008), West Virginia (#210), Wisconsin (#999518190), NAVY,
ARMY, USDA Soil Permit

EXECUTIVE SUMMARY - Detection Highlights

A0I270433

PARAMETER	RESULT	REPORTING LIMIT	UNITS	ANALYTICAL METHOD
CRS-MW-MW5 09/23/10 14:16 001				
Acetone	1.9 J,B	10	ug/L	SW846 8260B
Chloroform	0.36 J	1.0	ug/L	SW846 8260B
1,1-Dichloroethane	4.4	1.0	ug/L	SW846 8260B
cis-1,2-Dichloroethene	2.2	1.0	ug/L	SW846 8260B
trans-1,2-Dichloroethene	0.24 J	1.0	ug/L	SW846 8260B
Tetrachloroethene	4.4	1.0	ug/L	SW846 8260B
1,1,1-Trichloroethane	0.41 J	1.0	ug/L	SW846 8260B
Trichloroethene	3.3	1.0	ug/L	SW846 8260B
1,1,2-Trichloro- 1,2,2-trifluoroethane	2.6	1.0	ug/L	SW846 8260B
Vinyl chloride	0.45 J	1.0	ug/L	SW846 8260B
CRS-MW-MW50 09/23/10 14:20 002				
Acetone	2.0 J,B	10	ug/L	SW846 8260B
Chloroform	0.35 J	1.0	ug/L	SW846 8260B
1,1-Dichloroethane	4.4	1.0	ug/L	SW846 8260B
cis-1,2-Dichloroethene	2.1	1.0	ug/L	SW846 8260B
trans-1,2-Dichloroethene	0.24 J	1.0	ug/L	SW846 8260B
Tetrachloroethene	4.2	1.0	ug/L	SW846 8260B
1,1,1-Trichloroethane	0.40 J	1.0	ug/L	SW846 8260B
Trichloroethene	3.3	1.0	ug/L	SW846 8260B
1,1,2-Trichloro- 1,2,2-trifluoroethane	2.5	1.0	ug/L	SW846 8260B
Vinyl chloride	0.42 J	1.0	ug/L	SW846 8260B
CRS-MW-MW16 09/23/10 15:30 003				
Acetone	1.4 J,B	10	ug/L	SW846 8260B
1,1-Dichloroethane	0.29 J	1.0	ug/L	SW846 8260B
cis-1,2-Dichloroethene	0.42 J	1.0	ug/L	SW846 8260B
Tetrachloroethene	6.6	1.0	ug/L	SW846 8260B
1,1,1-Trichloroethane	0.40 J	1.0	ug/L	SW846 8260B
Trichloroethene	1.9	1.0	ug/L	SW846 8260B
CRS-MW-L2 09/23/10 16:32 004				
Chloroform	9.4	1.0	ug/L	SW846 8260B

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EXECUTIVE SUMMARY - Detection Highlights

A0I270433

<u>PARAMETER</u>	<u>RESULT</u>	<u>REPORTING LIMIT</u>	<u>UNITS</u>	<u>ANALYTICAL METHOD</u>
TRIP BLANK 09/23/10 006				
Acetone	6.6 J,B	10	ug/L	SW846 8260B
Methylene chloride	3.0	1.0	ug/L	SW846 8260B

ANALYTICAL METHODS SUMMARY

A0I270433

<u>PARAMETER</u>	<u>ANALYTICAL METHOD</u>
Volatile Organics by GC/MS	SW846 8260B

References:

SW846 "Test Methods for Evaluating Solid Waste, Physical/Chemical Methods", Third Edition, November 1986 and its updates.

SAMPLE SUMMARY

A0I270433

WO #	SAMPLE#	CLIENT SAMPLE ID	SAMPLED DATE	SAMP TIME
L7J0Q	001	CRS-MW-MW5	09/23/10	14:16
L7J0W	002	CRS-MW-MW50	09/23/10	14:20
L7J0X	003	CRS-MW-MW16	09/23/10	15:30
L7J01	004	CRS-MW-L2	09/23/10	16:32
L7J02	005	CRS-MW-L3	09/23/10	17:35
L7J03	006	TRIP BLANK	09/23/10	

NOTE(S) :

- The analytical results of the samples listed above are presented on the following pages.
- All calculations are performed before rounding to avoid round-off errors in calculated results.
- Results noted as "ND" were not detected at or above the stated limit.
- This report must not be reproduced, except in full, without the written approval of the laboratory.
- Results for the following parameters are never reported on a dry weight basis: color, corrosivity, density, flashpoint, ignitability, layers, odor, paint filter test, pH, porosity pressure, reactivity, redox potential, specific gravity, spot tests, solids, solubility, temperature, viscosity, and weight.

Brown and Caldwell

Client Sample ID: CRS-MW-MW5

GC/MS Volatiles

Lot-Sample #...: A0I270433-001 Work Order #...: L7J0Q1AA Matrix.....: WG
 Date Sampled...: 09/23/10 14:16 Date Received...: 09/27/10
 Prep Date.....: 10/04/10 Analysis Date...: 10/04/10
 Prep Batch #...: 0277176
 Dilution Factor: 1 Method.....: SW846 8260B

PARAMETER	RESULT	REPORTING		
		LIMIT	UNITS	MDL
Acetone	1.9 J,B	10	ug/L	1.1
Benzene	ND	1.0	ug/L	0.13
Bromodichloromethane	ND	1.0	ug/L	0.15
Bromoform	ND	1.0	ug/L	0.64
Bromomethane	ND	1.0	ug/L	0.41
2-Butanone	ND	10	ug/L	0.57
Carbon disulfide	ND	1.0	ug/L	0.13
Carbon tetrachloride	ND	1.0	ug/L	0.13
Chlorobenzene	ND	1.0	ug/L	0.15
Dibromochloromethane	ND	1.0	ug/L	0.18
Chloroethane	ND	1.0	ug/L	0.29
Chloroform	0.36 J	1.0	ug/L	0.16
Chloromethane	ND	1.0	ug/L	0.30
Cyclohexane	ND	1.0	ug/L	0.12
1,2-Dibromo-3-chloro-propane	ND	2.0	ug/L	0.67
1,2-Dibromoethane	ND	1.0	ug/L	0.24
1,2-Dichlorobenzene	ND	1.0	ug/L	0.13
1,3-Dichlorobenzene	ND	1.0	ug/L	0.14
1,4-Dichlorobenzene	ND	1.0	ug/L	0.13
Dichlorodifluoromethane	ND	1.0	ug/L	0.31
1,1-Dichloroethane	4.4	1.0	ug/L	0.15
1,2-Dichloroethane	ND	1.0	ug/L	0.22
cis-1,2-Dichloroethene	2.2	1.0	ug/L	0.17
trans-1,2-Dichloroethene	0.24 J	1.0	ug/L	0.19
1,1-Dichloroethene	ND	1.0	ug/L	0.19
1,2-Dichloropropane	ND	1.0	ug/L	0.18
cis-1,3-Dichloropropene	ND	1.0	ug/L	0.14
trans-1,3-Dichloropropene	ND	1.0	ug/L	0.19
Ethylbenzene	ND	1.0	ug/L	0.17
2-Hexanone	ND	10	ug/L	0.41
Isopropylbenzene	ND	1.0	ug/L	0.13
Methyl acetate	ND	10	ug/L	0.38
Methylcyclohexane	ND	1.0	ug/L	0.13
Methylene chloride	ND	1.0	ug/L	0.33
4-Methyl-2-pentanone	ND	10	ug/L	0.32
Methyl tert-butyl ether	ND	5.0	ug/L	0.17
Styrene	ND	1.0	ug/L	0.11
1,1,2,2-Tetrachloroethane	ND	1.0	ug/L	0.18

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Brown and Caldwell

Client Sample ID: CRS-MW-MW5

GC/MS Volatiles

Lot-Sample #...: A0I270433-001 Work Order #...: L7J0Q1AA Matrix.....: WG

PARAMETER	RESULT	REPORTING		
		LIMIT	UNITS	MDL
Tetrachloroethene	4.4	1.0	ug/L	0.29
Toluene	ND	1.0	ug/L	0.13
1,2,4-Trichloro- benzene	ND	1.0	ug/L	0.15
1,1,1-Trichloroethane	0.41 J	1.0	ug/L	0.22
1,1,2-Trichloroethane	ND	1.0	ug/L	0.27
Trichloroethene	3.3	1.0	ug/L	0.17
Trichlorofluoromethane	ND	1.0	ug/L	0.21
1,1,2-Trichloro- 1,2,2-trifluoroethane	2.6	1.0	ug/L	0.28
Vinyl chloride	0.45 J	1.0	ug/L	0.22
Xylenes (total)	ND	2.0	ug/L	0.28

SURROGATE	PERCENT	
	RECOVERY	RECOVERY LIMITS
Dibromofluoromethane	93	(73 - 122)
1,2-Dichloroethane-d4	90	(61 - 128)
Toluene-d8	100	(76 - 110)
4-Bromofluorobenzene	93	(74 - 116)

NOTE(S):

J Estimated result. Result is less than RL.

B Method blank contamination. The associated method blank contains the target analyte at a reportable level.

Brown and Caldwell

Client Sample ID: CRS-MW-MW50

GC/MS Volatiles

Lot-Sample #...: A0I270433-002 Work Order #...: L7J0W1AA Matrix.....: WG
 Date Sampled...: 09/23/10 14:20 Date Received...: 09/27/10
 Prep Date.....: 10/04/10 Analysis Date...: 10/04/10
 Prep Batch #...: 0277176
 Dilution Factor: 1 Method.....: SW846 8260B

PARAMETER	RESULT	REPORTING		
		LIMIT	UNITS	MDL
Acetone	2.0 J,B	10	ug/L	1.1
Benzene	ND	1.0	ug/L	0.13
Bromodichloromethane	ND	1.0	ug/L	0.15
Bromoform	ND	1.0	ug/L	0.64
Bromomethane	ND	1.0	ug/L	0.41
2-Butanone	ND	10	ug/L	0.57
Carbon disulfide	ND	1.0	ug/L	0.13
Carbon tetrachloride	ND	1.0	ug/L	0.13
Chlorobenzene	ND	1.0	ug/L	0.15
Dibromochloromethane	ND	1.0	ug/L	0.18
Chloroethane	ND	1.0	ug/L	0.29
Chloroform	0.35 J	1.0	ug/L	0.16
Chloromethane	ND	1.0	ug/L	0.30
Cyclohexane	ND	1.0	ug/L	0.12
1,2-Dibromo-3-chloro-propane	ND	2.0	ug/L	0.67
1,2-Dibromoethane	ND	1.0	ug/L	0.24
1,2-Dichlorobenzene	ND	1.0	ug/L	0.13
1,3-Dichlorobenzene	ND	1.0	ug/L	0.14
1,4-Dichlorobenzene	ND	1.0	ug/L	0.13
Dichlorodifluoromethane	ND	1.0	ug/L	0.31
1,1-Dichloroethane	4.4	1.0	ug/L	0.15
1,2-Dichloroethane	ND	1.0	ug/L	0.22
cis-1,2-Dichloroethene	2.1	1.0	ug/L	0.17
trans-1,2-Dichloroethene	0.24 J	1.0	ug/L	0.19
1,1-Dichloroethene	ND	1.0	ug/L	0.19
1,2-Dichloropropane	ND	1.0	ug/L	0.18
cis-1,3-Dichloropropene	ND	1.0	ug/L	0.14
trans-1,3-Dichloropropene	ND	1.0	ug/L	0.19
Ethylbenzene	ND	1.0	ug/L	0.17
2-Hexanone	ND	10	ug/L	0.41
Isopropylbenzene	ND	1.0	ug/L	0.13
Methyl acetate	ND	10	ug/L	0.38
Methylcyclohexane	ND	1.0	ug/L	0.13
Methylene chloride	ND	1.0	ug/L	0.33
4-Methyl-2-pentanone	ND	10	ug/L	0.32
Methyl tert-butyl ether	ND	5.0	ug/L	0.17
Styrene	ND	1.0	ug/L	0.11
1,1,2,2-Tetrachloroethane	ND	1.0	ug/L	0.18

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Brown and Caldwell

Client Sample ID: CRS-MW-MW50

GC/MS Volatiles

Lot-Sample #...: A0I270433-002 Work Order #...: L7J0W1AA Matrix.....: WG

PARAMETER	RESULT	REPORTING		
		LIMIT	UNITS	MDL
Tetrachloroethene	4.2	1.0	ug/L	0.29
Toluene	ND	1.0	ug/L	0.13
1,2,4-Trichloro- benzene	ND	1.0	ug/L	0.15
1,1,1-Trichloroethane	0.40 J	1.0	ug/L	0.22
1,1,2-Trichloroethane	ND	1.0	ug/L	0.27
Trichloroethene	3.3	1.0	ug/L	0.17
Trichlorofluoromethane	ND	1.0	ug/L	0.21
1,1,2-Trichloro- 1,2,2-trifluoroethane	2.5	1.0	ug/L	0.28
Vinyl chloride	0.42 J	1.0	ug/L	0.22
Xylenes (total)	ND	2.0	ug/L	0.28
SURROGATE	PERCENT		RECOVERY	
	RECOVERY		LIMITS	
Dibromofluoromethane	92		(73 - 122)	
1,2-Dichloroethane-d4	92		(61 - 128)	
Toluene-d8	99		(76 - 110)	
4-Bromofluorobenzene	91		(74 - 116)	

NOTE(S):

J Estimated result. Result is less than RL.

B Method blank contamination. The associated method blank contains the target analyte at a reportable level.

Brown and Caldwell

Client Sample ID: CRS-MW-MW16

GC/MS Volatiles

Lot-Sample #...: A0I270433-003 Work Order #...: L7J0X1AA Matrix.....: WG
 Date Sampled...: 09/23/10 15:30 Date Received...: 09/27/10
 Prep Date.....: 10/04/10 Analysis Date...: 10/04/10
 Prep Batch #...: 0277176
 Dilution Factor: 1 Method.....: SW846 8260B

PARAMETER	RESULT	REPORTING		
		LIMIT	UNITS	MDL
Acetone	1.4 J,B	10	ug/L	1.1
Benzene	ND	1.0	ug/L	0.13
Bromodichloromethane	ND	1.0	ug/L	0.15
Bromoform	ND	1.0	ug/L	0.64
Bromomethane	ND	1.0	ug/L	0.41
2-Butanone	ND	10	ug/L	0.57
Carbon disulfide	ND	1.0	ug/L	0.13
Carbon tetrachloride	ND	1.0	ug/L	0.13
Chlorobenzene	ND	1.0	ug/L	0.15
Dibromochloromethane	ND	1.0	ug/L	0.18
Chloroethane	ND	1.0	ug/L	0.29
Chloroform	ND	1.0	ug/L	0.16
Chloromethane	ND	1.0	ug/L	0.30
Cyclohexane	ND	1.0	ug/L	0.12
1,2-Dibromo-3-chloro- propane	ND	2.0	ug/L	0.67
1,2-Dibromoethane	ND	1.0	ug/L	0.24
1,2-Dichlorobenzene	ND	1.0	ug/L	0.13
1,3-Dichlorobenzene	ND	1.0	ug/L	0.14
1,4-Dichlorobenzene	ND	1.0	ug/L	0.13
Dichlorodifluoromethane	ND	1.0	ug/L	0.31
1,1-Dichloroethane	0.29 J	1.0	ug/L	0.15
1,2-Dichloroethane	ND	1.0	ug/L	0.22
cis-1,2-Dichloroethene	0.42 J	1.0	ug/L	0.17
trans-1,2-Dichloroethene	ND	1.0	ug/L	0.19
1,1-Dichloroethene	ND	1.0	ug/L	0.19
1,2-Dichloropropane	ND	1.0	ug/L	0.18
cis-1,3-Dichloropropene	ND	1.0	ug/L	0.14
trans-1,3-Dichloropropene	ND	1.0	ug/L	0.19
Ethylbenzene	ND	1.0	ug/L	0.17
2-Hexanone	ND	10	ug/L	0.41
Isopropylbenzene	ND	1.0	ug/L	0.13
Methyl acetate	ND	10	ug/L	0.38
Methylcyclohexane	ND	1.0	ug/L	0.13
Methylene chloride	ND	1.0	ug/L	0.33
4-Methyl-2-pentanone	ND	10	ug/L	0.32
Methyl tert-butyl ether	ND	5.0	ug/L	0.17
Styrene	ND	1.0	ug/L	0.11
1,1,2,2-Tetrachloroethane	ND	1.0	ug/L	0.18

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Brown and Caldwell

Client Sample ID: CRS-MW-MW16

GC/MS Volatiles

Lot-Sample #...: A0I270433-003 Work Order #...: L7J0X1AA Matrix.....: WG

		REPORTING		
PARAMETER	RESULT	LIMIT	UNITS	MDL
Tetrachloroethene	6.6	1.0	ug/L	0.29
Toluene	ND	1.0	ug/L	0.13
1,2,4-Trichloro- benzene	ND	1.0	ug/L	0.15
1,1,1-Trichloroethane	0.40 J	1.0	ug/L	0.22
1,1,2-Trichloroethane	ND	1.0	ug/L	0.27
Trichloroethene	1.9	1.0	ug/L	0.17
Trichlorofluoromethane	ND	1.0	ug/L	0.21
1,1,2-Trichloro- 1,2,2-trifluoroethane	ND	1.0	ug/L	0.28
Vinyl chloride	ND	1.0	ug/L	0.22
Xylenes (total)	ND	2.0	ug/L	0.28
		PERCENT	RECOVERY	
SURROGATE	RECOVERY	LIMITS		
Dibromofluoromethane	90	(73 - 122)		
1,2-Dichloroethane-d4	92	(61 - 128)		
Toluene-d8	100	(76 - 110)		
4-Bromofluorobenzene	93	(74 - 116)		

NOTE(S):

J Estimated result. Result is less than RL.

B Method blank contamination. The associated method blank contains the target analyte at a reportable level.

Brown and Caldwell

Client Sample ID: CRS-MW-L2

GC/MS Volatiles

Lot-Sample #...: A0I270433-004 Work Order #...: L7J011AA Matrix.....: WG
 Date Sampled...: 09/23/10 16:32 Date Received...: 09/27/10
 Prep Date.....: 10/04/10 Analysis Date...: 10/04/10
 Prep Batch #...: 0277176
 Dilution Factor: 1 Method.....: SW846 8260B

PARAMETER	RESULT	REPORTING		
		LIMIT	UNITS	MDL
Acetone	ND	10	ug/L	1.1
Benzene	ND	1.0	ug/L	0.13
Bromodichloromethane	ND	1.0	ug/L	0.15
Bromoform	ND	1.0	ug/L	0.64
Bromomethane	ND	1.0	ug/L	0.41
2-Butanone	ND	10	ug/L	0.57
Carbon disulfide	ND	1.0	ug/L	0.13
Carbon tetrachloride	ND	1.0	ug/L	0.13
Chlorobenzene	ND	1.0	ug/L	0.15
Dibromochloromethane	ND	1.0	ug/L	0.18
Chloroethane	ND	1.0	ug/L	0.29
Chloroform	9.4	1.0	ug/L	0.16
Chloromethane	ND	1.0	ug/L	0.30
Cyclohexane	ND	1.0	ug/L	0.12
1,2-Dibromo-3-chloro- propane	ND	2.0	ug/L	0.67
1,2-Dibromoethane	ND	1.0	ug/L	0.24
1,2-Dichlorobenzene	ND	1.0	ug/L	0.13
1,3-Dichlorobenzene	ND	1.0	ug/L	0.14
1,4-Dichlorobenzene	ND	1.0	ug/L	0.13
Dichlorodifluoromethane	ND	1.0	ug/L	0.31
1,1-Dichloroethane	ND	1.0	ug/L	0.15
1,2-Dichloroethane	ND	1.0	ug/L	0.22
cis-1,2-Dichloroethene	ND	1.0	ug/L	0.17
trans-1,2-Dichloroethene	ND	1.0	ug/L	0.19
1,1-Dichloroethene	ND	1.0	ug/L	0.19
1,2-Dichloropropane	ND	1.0	ug/L	0.18
cis-1,3-Dichloropropene	ND	1.0	ug/L	0.14
trans-1,3-Dichloropropene	ND	1.0	ug/L	0.19
Ethylbenzene	ND	1.0	ug/L	0.17
2-Hexanone	ND	10	ug/L	0.41
Isopropylbenzene	ND	1.0	ug/L	0.13
Methyl acetate	ND	10	ug/L	0.38
Methylcyclohexane	ND	1.0	ug/L	0.13
Methylene chloride	ND	1.0	ug/L	0.33
4-Methyl-2-pentanone	ND	10	ug/L	0.32
Methyl tert-butyl ether	ND	5.0	ug/L	0.17
Styrene	ND	1.0	ug/L	0.11
1,1,2,2-Tetrachloroethane	ND	1.0	ug/L	0.18

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Brown and Caldwell

Client Sample ID: CRS-MW-L2

GC/MS Volatiles

Lot-Sample #...: A0I270433-004 Work Order #...: L7J011AA Matrix.....: WG

<u>PARAMETER</u>	<u>RESULT</u>	<u>REPORTING</u>		
		<u>LIMIT</u>	<u>UNITS</u>	<u>MDL</u>
Tetrachloroethene	ND	1.0	ug/L	0.29
Toluene	ND	1.0	ug/L	0.13
1,2,4-Trichloro- benzene	ND	1.0	ug/L	0.15
1,1,1-Trichloroethane	ND	1.0	ug/L	0.22
1,1,2-Trichloroethane	ND	1.0	ug/L	0.27
Trichloroethene	ND	1.0	ug/L	0.17
Trichlorofluoromethane	ND	1.0	ug/L	0.21
1,1,2-Trichloro- 1,2,2-trifluoroethane	ND	1.0	ug/L	0.28
Vinyl chloride	ND	1.0	ug/L	0.22
Xylenes (total)	ND	2.0	ug/L	0.28
<u>SURROGATE</u>	<u>PERCENT</u>		<u>RECOVERY</u>	
	<u>RECOVERY</u>		<u>LIMITS</u>	
Dibromofluoromethane	93		(73 - 122)	
1,2-Dichloroethane-d4	91		(61 - 128)	
Toluene-d8	100		(76 - 110)	
4-Bromofluorobenzene	93		(74 - 116)	

Brown and Caldwell

Client Sample ID: CRS-MW-L3

GC/MS Volatiles

Lot-Sample #...: A0I270433-005 Work Order #...: L7J021AA Matrix.....: WG
 Date Sampled...: 09/23/10 17:35 Date Received...: 09/27/10
 Prep Date.....: 10/04/10 Analysis Date...: 10/04/10
 Prep Batch #...: 0277176
 Dilution Factor: 1 Method.....: SW846 8260B

PARAMETER	RESULT	REPORTING		
		LIMIT	UNITS	MDL
Acetone	ND	10	ug/L	1.1
Benzene	ND	1.0	ug/L	0.13
Bromodichloromethane	ND	1.0	ug/L	0.15
Bromoform	ND	1.0	ug/L	0.64
Bromomethane	ND	1.0	ug/L	0.41
2-Butanone	ND	10	ug/L	0.57
Carbon disulfide	ND	1.0	ug/L	0.13
Carbon tetrachloride	ND	1.0	ug/L	0.13
Chlorobenzene	ND	1.0	ug/L	0.15
Dibromochloromethane	ND	1.0	ug/L	0.18
Chloroethane	ND	1.0	ug/L	0.29
Chloroform	ND	1.0	ug/L	0.16
Chloromethane	ND	1.0	ug/L	0.30
Cyclohexane	ND	1.0	ug/L	0.12
1,2-Dibromo-3-chloro- propane	ND	2.0	ug/L	0.67
1,2-Dibromoethane	ND	1.0	ug/L	0.24
1,2-Dichlorobenzene	ND	1.0	ug/L	0.13
1,3-Dichlorobenzene	ND	1.0	ug/L	0.14
1,4-Dichlorobenzene	ND	1.0	ug/L	0.13
Dichlorodifluoromethane	ND	1.0	ug/L	0.31
1,1-Dichloroethane	ND	1.0	ug/L	0.15
1,2-Dichloroethane	ND	1.0	ug/L	0.22
cis-1,2-Dichloroethene	ND	1.0	ug/L	0.17
trans-1,2-Dichloroethene	ND	1.0	ug/L	0.19
1,1-Dichloroethene	ND	1.0	ug/L	0.19
1,2-Dichloropropane	ND	1.0	ug/L	0.18
cis-1,3-Dichloropropene	ND	1.0	ug/L	0.14
trans-1,3-Dichloropropene	ND	1.0	ug/L	0.19
Ethylbenzene	ND	1.0	ug/L	0.17
2-Hexanone	ND	10	ug/L	0.41
Isopropylbenzene	ND	1.0	ug/L	0.13
Methyl acetate	ND	10	ug/L	0.38
Methylcyclohexane	ND	1.0	ug/L	0.13
Methylene chloride	ND	1.0	ug/L	0.33
4-Methyl-2-pentanone	ND	10	ug/L	0.32
Methyl tert-butyl ether	ND	5.0	ug/L	0.17
Styrene	ND	1.0	ug/L	0.11
1,1,2,2-Tetrachloroethane	ND	1.0	ug/L	0.18

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Brown and Caldwell

Client Sample ID: CRS-MW-L3

GC/MS Volatiles

Lot-Sample #...: A0I270433-005 Work Order #...: L7J021AA Matrix.....: WG

<u>PARAMETER</u>	<u>RESULT</u>	<u>REPORTING</u>		
		<u>LIMIT</u>	<u>UNITS</u>	<u>MDL</u>
Tetrachloroethene	ND	1.0	ug/L	0.29
Toluene	ND	1.0	ug/L	0.13
1,2,4-Trichloro- benzene	ND	1.0	ug/L	0.15
1,1,1-Trichloroethane	ND	1.0	ug/L	0.22
1,1,2-Trichloroethane	ND	1.0	ug/L	0.27
Trichloroethene	ND	1.0	ug/L	0.17
Trichlorofluoromethane	ND	1.0	ug/L	0.21
1,1,2-Trichloro- 1,2,2-trifluoroethane	ND	1.0	ug/L	0.28
Vinyl chloride	ND	1.0	ug/L	0.22
Xylenes (total)	ND	2.0	ug/L	0.28
<u>SURROGATE</u>	<u>PERCENT</u>		<u>RECOVERY</u>	
	<u>RECOVERY</u>		<u>LIMITS</u>	
Dibromofluoromethane	92		(73 - 122)	
1,2-Dichloroethane-d4	92		(61 - 128)	
Toluene-d8	99		(76 - 110)	
4-Bromofluorobenzene	92		(74 - 116)	

Brown and Caldwell

Client Sample ID: TRIP BLANK

GC/MS Volatiles

Lot-Sample #...: A0I270433-006 Work Order #...: L7J031AA Matrix.....: WQ
 Date Sampled...: 09/23/10 Date Received...: 09/27/10
 Prep Date.....: 10/04/10 Analysis Date...: 10/04/10
 Prep Batch #...: 0277176
 Dilution Factor: 1 Method.....: SW846 8260B

PARAMETER	RESULT	REPORTING		
		LIMIT	UNITS	MDL
Acetone	6.6 J,B	10	ug/L	1.1
Benzene	ND	1.0	ug/L	0.13
Bromodichloromethane	ND	1.0	ug/L	0.15
Bromoform	ND	1.0	ug/L	0.64
Bromomethane	ND	1.0	ug/L	0.41
2-Butanone	ND	10	ug/L	0.57
Carbon disulfide	ND	1.0	ug/L	0.13
Carbon tetrachloride	ND	1.0	ug/L	0.13
Chlorobenzene	ND	1.0	ug/L	0.15
Dibromochloromethane	ND	1.0	ug/L	0.18
Chloroethane	ND	1.0	ug/L	0.29
Chloroform	ND	1.0	ug/L	0.16
Chloromethane	ND	1.0	ug/L	0.30
Cyclohexane	ND	1.0	ug/L	0.12
1,2-Dibromo-3-chloro- propane	ND	2.0	ug/L	0.67
1,2-Dibromoethane	ND	1.0	ug/L	0.24
1,2-Dichlorobenzene	ND	1.0	ug/L	0.13
1,3-Dichlorobenzene	ND	1.0	ug/L	0.14
1,4-Dichlorobenzene	ND	1.0	ug/L	0.13
Dichlorodifluoromethane	ND	1.0	ug/L	0.31
1,1-Dichloroethane	ND	1.0	ug/L	0.15
1,2-Dichloroethane	ND	1.0	ug/L	0.22
cis-1,2-Dichloroethene	ND	1.0	ug/L	0.17
trans-1,2-Dichloroethene	ND	1.0	ug/L	0.19
1,1-Dichloroethene	ND	1.0	ug/L	0.19
1,2-Dichloropropane	ND	1.0	ug/L	0.18
cis-1,3-Dichloropropene	ND	1.0	ug/L	0.14
trans-1,3-Dichloropropene	ND	1.0	ug/L	0.19
Ethylbenzene	ND	1.0	ug/L	0.17
2-Hexanone	ND	10	ug/L	0.41
Isopropylbenzene	ND	1.0	ug/L	0.13
Methyl acetate	ND	10	ug/L	0.38
Methylcyclohexane	ND	1.0	ug/L	0.13
Methylene chloride	3.0	1.0	ug/L	0.33
4-Methyl-2-pentanone	ND	10	ug/L	0.32
Methyl tert-butyl ether	ND	5.0	ug/L	0.17
Styrene	ND	1.0	ug/L	0.11
1,1,2,2-Tetrachloroethane	ND	1.0	ug/L	0.18

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Brown and Caldwell

Client Sample ID: TRIP BLANK

GC/MS Volatiles

Lot-Sample #...: A0I270433-006 Work Order #...: L7J031AA Matrix.....: WQ

PARAMETER	RESULT	REPORTING		
		LIMIT	UNITS	MDL
Tetrachloroethene	ND	1.0	ug/L	0.29
Toluene	ND	1.0	ug/L	0.13
1,2,4-Trichloro- benzene	ND	1.0	ug/L	0.15
1,1,1-Trichloroethane	ND	1.0	ug/L	0.22
1,1,2-Trichloroethane	ND	1.0	ug/L	0.27
Trichloroethene	ND	1.0	ug/L	0.17
Trichlorofluoromethane	ND	1.0	ug/L	0.21
1,1,2-Trichloro- 1,2,2-trifluoroethane	ND	1.0	ug/L	0.28
Vinyl chloride	ND	1.0	ug/L	0.22
Xylenes (total)	ND	2.0	ug/L	0.28

SURROGATE	PERCENT		RECOVERY	
	RECOVERY		LIMITS	
Dibromofluoromethane	92		(73 - 122)	
1,2-Dichloroethane-d4	91		(61 - 128)	
Toluene-d8	100		(76 - 110)	
4-Bromofluorobenzene	93		(74 - 116)	

NOTE(S):

J Estimated result. Result is less than RL.

B Method blank contamination. The associated method blank contains the target analyte at a reportable level.

QUALITY CONTROL SECTION

METHOD BLANK REPORT

GC/MS Volatiles

Client Lot #...: A0I270433
MB Lot-Sample #: A0J040000-176

Work Order #...: L7XW81AA

Matrix.....: WATER

Analysis Date...: 10/04/10

Prep Date.....: 10/04/10

Prep Batch #...: 0277176

Dilution Factor: 1

PARAMETER	RESULT	REPORTING			METHOD
		LIMIT	UNITS		
Acetone	1.4 J	10	ug/L		SW846 8260B
Benzene	ND	1.0	ug/L		SW846 8260B
Bromodichloromethane	ND	1.0	ug/L		SW846 8260B
Bromoform	ND	1.0	ug/L		SW846 8260B
Bromomethane	ND	1.0	ug/L		SW846 8260B
2-Butanone	ND	10	ug/L		SW846 8260B
Carbon disulfide	ND	1.0	ug/L		SW846 8260B
Carbon tetrachloride	ND	1.0	ug/L		SW846 8260B
Chlorobenzene	ND	1.0	ug/L		SW846 8260B
Dibromochloromethane	ND	1.0	ug/L		SW846 8260B
Chloroethane	ND	1.0	ug/L		SW846 8260B
Chloroform	ND	1.0	ug/L		SW846 8260B
Chloromethane	ND	1.0	ug/L		SW846 8260B
Cyclohexane	ND	1.0	ug/L		SW846 8260B
1,2-Dibromo-3-chloro-propane	ND	2.0	ug/L		SW846 8260B
1,2-Dibromoethane	ND	1.0	ug/L		SW846 8260B
1,2-Dichlorobenzene	ND	1.0	ug/L		SW846 8260B
1,3-Dichlorobenzene	ND	1.0	ug/L		SW846 8260B
1,4-Dichlorobenzene	ND	1.0	ug/L		SW846 8260B
Dichlorodifluoromethane	ND	1.0	ug/L		SW846 8260B
1,1-Dichloroethane	ND	1.0	ug/L		SW846 8260B
1,2-Dichloroethane	ND	1.0	ug/L		SW846 8260B
cis-1,2-Dichloroethene	ND	1.0	ug/L		SW846 8260B
trans-1,2-Dichloroethene	ND	1.0	ug/L		SW846 8260B
1,1-Dichloroethene	ND	1.0	ug/L		SW846 8260B
1,2-Dichloropropane	ND	1.0	ug/L		SW846 8260B
cis-1,3-Dichloropropene	ND	1.0	ug/L		SW846 8260B
trans-1,3-Dichloropropene	ND	1.0	ug/L		SW846 8260B
Ethylbenzene	ND	1.0	ug/L		SW846 8260B
2-Hexanone	ND	10	ug/L		SW846 8260B
Isopropylbenzene	ND	1.0	ug/L		SW846 8260B
Methyl acetate	ND	10	ug/L		SW846 8260B
Methylcyclohexane	ND	1.0	ug/L		SW846 8260B
Methylene chloride	ND	1.0	ug/L		SW846 8260B
4-Methyl-2-pentanone	ND	10	ug/L		SW846 8260B
Methyl tert-butyl ether	ND	5.0	ug/L		SW846 8260B
Styrene	ND	1.0	ug/L		SW846 8260B
1,1,2,2-Tetrachloroethane	ND	1.0	ug/L		SW846 8260B
Tetrachloroethene	ND	1.0	ug/L		SW846 8260B
Toluene	ND	1.0	ug/L		SW846 8260B

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METHOD BLANK REPORT

GC/MS Volatiles

Client Lot #...: A0I270433

Work Order #...: L7XW81AA

Matrix.....: WATER

PARAMETER	RESULT	REPORTING		METHOD
		LIMIT	UNITS	
1,2,4-Trichloro-benzene	ND	1.0	ug/L	SW846 8260B
1,1,1-Trichloroethane	ND	1.0	ug/L	SW846 8260B
1,1,2-Trichloroethane	ND	1.0	ug/L	SW846 8260B
Trichloroethene	ND	1.0	ug/L	SW846 8260B
Trichlorofluoromethane	ND	1.0	ug/L	SW846 8260B
1,1,2-Trichloro-1,2,2-trifluoroethane	ND	1.0	ug/L	SW846 8260B
Vinyl chloride	ND	1.0	ug/L	SW846 8260B
Xylenes (total)	ND	2.0	ug/L	SW846 8260B

SURROGATE	PERCENT	RECOVERY
	RECOVERY	LIMITS
Dibromofluoromethane	91	(73 - 122)
1,2-Dichloroethane-d4	92	(61 - 128)
Toluene-d8	99	(76 - 110)
4-Bromofluorobenzene	93	(74 - 116)

NOTE(S):

Calculations are performed before rounding to avoid round-off errors in calculated results.

J Estimated result. Result is less than RL.

LABORATORY CONTROL SAMPLE EVALUATION REPORT

GC/MS Volatiles

Client Lot #...: A0I270433 Work Order #...: L7XW81AC-LCS Matrix.....: WATER
 LCS Lot-Sample#: A0J040000-176 L7XW81AD-LCSD
 Prep Date.....: 10/03/10 Analysis Date...: 10/03/10
 Prep Batch #...: 0277176
 Dilution Factor: 1

PARAMETER	PERCENT RECOVERY	RECOVERY LIMITS	RPD	RPD LIMITS	METHOD
Benzene	103	(80 - 116)			SW846 8260B
	101	(80 - 116)	1.7	(0-20)	SW846 8260B
Chlorobenzene	101	(76 - 117)			SW846 8260B
	98	(76 - 117)	2.6	(0-20)	SW846 8260B
1,1-Dichloroethene	103	(63 - 130)			SW846 8260B
	101	(63 - 130)	1.8	(0-20)	SW846 8260B
Toluene	100	(74 - 119)			SW846 8260B
	99	(74 - 119)	0.68	(0-20)	SW846 8260B
Trichloroethene	105	(75 - 122)			SW846 8260B
	104	(75 - 122)	0.57	(0-20)	SW846 8260B

SURROGATE	PERCENT RECOVERY	RECOVERY LIMITS
Dibromofluoromethane	95	(73 - 122)
	94	(73 - 122)
1,2-Dichloroethane-d4	93	(61 - 128)
	90	(61 - 128)
Toluene-d8	100	(76 - 110)
	100	(76 - 110)
4-Bromofluorobenzene	95	(74 - 116)
	94	(74 - 116)

NOTE(S):

Calculations are performed before rounding to avoid round-off errors in calculated results.

Bold print denotes control parameters

MATRIX SPIKE SAMPLE EVALUATION REPORT

GC/MS Volatiles

Client Lot #...: A0I270433 Work Order #...: L7L0J1AC-MS Matrix.....: WATER
 MS Lot-Sample #: A0I280520-010 L7L0J1AD-MSD
 Date Sampled...: 09/27/10 16:20 Date Received...: 09/28/10
 Prep Date.....: 10/04/10 Analysis Date...: 10/04/10
 Prep Batch #...: 0277176
 Dilution Factor: 4

PARAMETER	PERCENT RECOVERY	RECOVERY LIMITS	RPD	RPD LIMITS	METHOD
Benzene	102	(78 - 118)			SW846 8260B
	102	(78 - 118)	0.47	(0-20)	SW846 8260B
Chlorobenzene	97	(76 - 117)			SW846 8260B
	98	(76 - 117)	0.34	(0-20)	SW846 8260B
1,1-Dichloroethene	98	(62 - 130)			SW846 8260B
	97	(62 - 130)	0.46	(0-20)	SW846 8260B
Toluene	98	(70 - 119)			SW846 8260B
	98	(70 - 119)	0.01	(0-20)	SW846 8260B
Trichloroethene	87	(62 - 130)			SW846 8260B
	73	(62 - 130)	3.6	(0-20)	SW846 8260B

SURROGATE	PERCENT RECOVERY	RECOVERY LIMITS
Dibromofluoromethane	93	(73 - 122)
	94	(73 - 122)
1,2-Dichloroethane-d4	97	(61 - 128)
	97	(61 - 128)
Toluene-d8	101	(76 - 110)
	100	(76 - 110)
4-Bromofluorobenzene	94	(74 - 116)
	92	(74 - 116)

NOTE(S):

Calculations are performed before rounding to avoid round-off errors in calculated results.

Bold print denotes control parameters

BROWN AND
CALDWELL

Chain of Custody Record

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COC No: 736

Page 1 of 1

Lab Quote No:

Lab:

Test Amonia

Address:

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North Canton, OH

44720



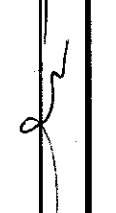
Phone:

Carrier: FED EX

Airbill: 799 4745 5154

Alerta Dayford

Remarks:

Project Name:	CRS - Elyria	1 None					Lab:	Test Amonia	
Project Location:	Elyria, OH	2 HCl					Address:	4101 Shuffelbush	
Project Number:	139452	3 H2SO4					North Canton, OH		
Project Manager:	James Peoples	4 HNO3					44720		
Sampler's Name:	James Peoples	5 NaOH					Phone:		
Sampler's Signature:		6 Other					Carrier:	FED EX	
Field Phone:	614-288-7201							Airbill:	799 4745 5154
Sample Identification		Sample Date	Sample Time	Sample Type	Matrix of Cont.	Total #			Alerta Dayford
CRS - MU - MU5	7/23/10	1416	grab water	3		X			
CRS - MU - MU50		1420		2		X			or bakery bottle
CRS - MU - MU16		1530		3		X			
CRS - MU - L2		1632		3		X			
CRS - MU - L3		1735		3		X			
Special Instructions/QC Requirements & Comments:									
Relinquished by:		Date/Time:	7/24/10	1630	Received by:		Date/Time:	7/27/10	930
Relinquished by:		Date/Time:			Received by:		Date/Time:		
Relinquished by:		Date/Time:			Received by:		Date/Time:		

Cooler TEMPERATURE upon arrival at laboratory _____ °C (To be filled in by LABORATORY upon receipt)
Distribution: WHITE - Accompanies shipment YELLOW - Returns with report PINK - Sampler's copy

TestAmerica Cooler Receipt Form/Narrative

Lot Number: A0I270433

North Canton Facility

Client Brown + Caldwell Project CRS - Glyria By: Ann

Cooler Received on 9/27/10 Opened on 9/27/10 (Signature) Ann

FedEx ☒ UPS ☐ DHL ☐ FAS ☐ Stetson ☐ Client Drop Off ☐ TestAmerica Courier ☐ Other ☐

TestAmerica Cooler # Multiple Coolers ☐ Foam Box ☐ Client Cooler ☒ Other ☐

1. Were custody seals on the outside of the cooler(s)? Yes ☐ No ☒ Intact? Yes ☐ No ☐ NA ☒

If YES, Quantity Quantity Unsalvageable

Were custody seals on the outside of cooler(s) signed and dated? Yes ☐ No ☐ NA ☒

Were custody seals on the bottle(s)? Yes ☐ No ☒

If YES, are there any exceptions? Yes ☒ No ☐

2. Shippers' packing slip attached to the cooler(s)? Yes ☒ No ☐

3. Did custody papers accompany the sample(s)? Yes ☒ No ☐ Relinquished by client? Yes ☒ No ☐

4. Were the custody papers signed in the appropriate place? Yes ☒ No ☐

5. Packing material used: Bubble Wrap ☒ Foam ☒ None ☐ Other

6. Cooler temperature upon receipt 3.4 °C See back of form for multiple coolers/temps ☐

METHOD: IR ☒ Other ☐

COOLANT: Wet Ice ☒ Blue Ice ☐ Dry Ice ☐ Water ☐ None ☐

7. Did all bottles arrive in good condition (Unbroken)? Yes ☒ No ☐

8. Could all bottle labels be reconciled with the COC? Yes ☒ No ☐

9. Were sample(s) at the correct pH upon receipt? Yes ☐ No ☐ NA ☒

10. Were correct bottle(s) used for the test(s) indicated? Yes ☒ No ☐

11. Were air bubbles >6 mm in any VOA vials? Yes ☐ No ☒ NA ☐

12. Sufficient quantity received to perform indicated analyses? Yes ☒ No ☐

13. Was a trip blank present in the cooler(s)? Yes ☒ No ☐ Were VOAs on the COC? Yes ☐ No ☒

Contacted PM Ann Date 9/27/10 by Ann via Verbal ☐ Voice Mail ☒ Other ☐

Concerning 14

14. CHAIN OF CUSTODY

The following discrepancies occurred:

Rec'd 1x40 TB not on COC will log.

15. SAMPLE CONDITION

Sample(s) were received after the recommended holding time had expired.

Sample(s) were received in a broken container.

Sample(s) were received with bubble >6 mm in diameter. (Notify PM)

16. SAMPLE PRESERVATION

Sample(s) were further preserved in Sample

Receiving to meet recommended pH level(s). Nitric Acid Lot# 051010-HNO₃; Sulfuric Acid Lot# 051010-H₂SO₄; Sodium

Hydroxide Lot# 100108 -NaOH; Hydrochloric Acid Lot# 092006-HCl; Sodium Hydroxide and Zinc Acetate Lot# 100108-

(CH₃COO)₂ZN/NaOH. What time was preservative added to sample(s)?

Client ID	pH	Date	Initials

TestAmerica Cooler Receipt Form/Narrative North Canton Facility

[illegible]

Discrepancies Cont'd:

END OF REPORT

ANALYTICAL REPORT

REVISED

PROJECT NO. 139452

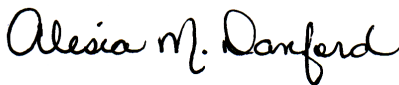
CRS ELYRIA

Lot #: A0I290542

James A. Peeples

Brown and Caldwell
4700 Lakehurst Court
Suite 100
Dublin, OH 43016

TESTAMERICA LABORATORIES, INC.



Alesia M. Danford
Project Manager
alesia.danford@testamericainc.com

Approved for release.
Alesia M. Danford
Project Manager
10/29/2010 12:59 PM

October 29, 2010

TestAmerica Laboratories, Inc.

TestAmerica North Canton 4101 Shuffel Street NW, North Canton, OH 44720

Tel (330)497-9396 Fax (330)497-0772 www.testamericainc.com



CASE NARRATIVE

A0I290542

Revised

The following report contains the analytical results for one waste sample and two water samples submitted to TestAmerica North Canton by Brown & Caldwell from the CRS ELYRIA Site, project number 139452. The samples were received September 29, 2010, according to documented sample acceptance procedures.

On 10/25/10, per Client request, the sample ID for A0I290452-003 was changed to CRS-MW-MW6B (DNAPL). Also the reporting limits for the sample were updated due to a laboratory oversight. All samples had three (3) compounds added to the volatile analysis per the client request.

TestAmerica utilizes USEPA approved methods in all analytical work. The samples presented in this report were analyzed for the parameter(s) listed on the analytical methods summary page in accordance with the method(s) indicated. Preliminary results were provided to James A. Peeples on October 18, 2010, and October 27, 2010. A summary of QC data for these analyses is included at the back of the report.

TestAmerica North Canton attests to the validity of the laboratory data generated by TestAmerica facilities reported herein. All analyses performed by TestAmerica facilities were done using established laboratory SOPs that incorporate QA/QC procedures described in the applicable methods. TestAmerica's operations groups have reviewed the data for compliance with the laboratory QA/QC plan, and data have been found to be compliant with laboratory protocols unless otherwise noted below.

The test results in this report meet all NELAP requirements for parameters for which accreditation is required or available. Any exceptions to NELAP requirements are noted in this report. Pursuant to NELAP, this report may not be reproduced, except in full, without the written approval of the laboratory. This laboratory report is confidential and is intended for the sole use of TestAmerica and its client.

All parameters were evaluated to the method detection limit and include qualified results where applicable.

Please refer to the Quality Control Elements Narrative following this case narrative for additional quality control information.

If you have any questions, please call the Project Manager, Alesia M. Danford, at 330-497-9396.

This report is sequentially paginated. The final page of the report is labeled as "END OF REPORT."

CASE NARRATIVE (continued)

SUPPLEMENTAL QC INFORMATION

SAMPLE RECEIVING

The temperature of the cooler upon sample receipt was 9.8°C.

Samples brought to the laboratory directly from the field.

GC/MS VOLATILES

The sample(s) that contained concentrations of target analyte(s) at a reportable level in the associated Method Blank(s) were flagged with "B". All target analytes in the Method Blank must be below the reporting limit (RL) or the associated sample(s) must be ND with the exception of common laboratory contaminants.

Result concentration exceeds the calibration range. Refer to the sample report pages for the affected compound(s) flagged with "E".

The sample(s) that contain results between the MDL and the RL were flagged with "J". There is a possibility of false positive or mis-identification at these quantitation levels. In analytical methods requiring confirmation of the analyte reported, confirmation was performed only down to the standard reporting limit (SRL). The acceptance criteria for QC samples may not be met at these quantitation levels.

The matrix spike/matrix spike duplicate(s) for batch(es) 0279231 had recoveries outside acceptance limits. However, since the associated method blank(s) and laboratory control sample(s) were in control, no corrective action was necessary.

The pH of the sample(s) CRS-MW-MW6A was greater than 2. The sample was analyzed within the normal 14 day holding time; however, experimental evidence suggests that some aromatic compounds in wastewater samples, notably, Benzene, Toluene, and Ethylbenzene are susceptible to biological degradation if samples are not preserved to a pH of 2.

Sample CRS-MW-MW6B (DNAPL) had analyte that exceeded calibration range. This analyte was added after the data had been initially reported. No corrective action was done

There were no client requested Matrix Spike/Matrix Spike Duplicate (MS/MSD) samples in batch 0285338. Therefore, the laboratory has included a Laboratory Control Sample Duplicate (LCSD) in the QC batch. The LCSD recoveries, together with the LCS recoveries, are used to determine the reproducibility (precision) of the analytical system.

QUALITY CONTROL ELEMENTS NARRATIVE

TestAmerica conducts a quality assurance/quality control (QA/QC) program designed to provide scientifically valid and legally defensible data. Toward this end, several types of quality control indicators are incorporated into the QA/QC program, which is described in detail in QA Policy, QA-003. These indicators are introduced into the sample testing process to provide a mechanism for the assessment of the analytical data. Program or agency specific requirements take precedence over the requirements listed in this narrative.

QC BATCH

Environmental samples are taken through the testing process in groups called QUALITY CONTROL BATCHES (QC batches). A QC batch contains up to twenty environmental samples of a similar matrix (water, soil) that are processed using the same reagents and standards. TestAmerica North Canton requires that each environmental sample be associated with a QC batch.

Several quality control samples are included in each QC batch and are processed identically to the twenty environmental samples.

For SW846/RCRA methods, QC samples include a METHOD BLANK (MB), a LABORATORY CONTROL SAMPLE (LCS) and, where appropriate, a MATRIX SPIKE/MATRIX SPIKE DUPLICATE (MS/MSD) pair or a MATRIX SPIKE/SAMPLE DUPLICATE (MS/DU) pair. If there is insufficient sample to perform an MS/MSD or an MS/DU, then a LABORATORY CONTROL SAMPLE DUPLICATE (LCSD) is included in the QC batch.

For 600 series/CWA methods, QC samples include a METHOD BLANK (MB), a LABORATORY CONTROL SAMPLE (LCS) and, where appropriate, a MATRIX SPIKE (MS). An MS is prepared and analyzed at a 10% frequency for GC Methods and at a 5% frequency for GC/MS methods.

LABORATORY CONTROL SAMPLE

The Laboratory Control Sample is a QC sample that is created by adding known concentrations of a full or partial set of target analytes to a matrix similar to that of the environmental samples in the QC batch. Multi peak responders may not be included in the target spike list due to co-elution. The LCS analyte recovery results are used to monitor the analytical process and provide evidence that the laboratory is performing the method within acceptable guidelines. All control analytes indicated by a bold type in the LCS must meet acceptance criteria. Failure to meet the established recovery guidelines requires the reparation and reanalysis of all samples in the QC batch. Comparison of only the failed parameters from the first batch are evaluated. The only exception to the rework requirement is that if the LCS recoveries are biased high and the associated sample is ND (non-detected) for the parameter(s) of interest, the batch is acceptable.

At times, a Laboratory Control Sample Duplicate (LCSD) is also included in the QC batch. An LCSD is a QC sample that is created and handled identically to the LCS. Analyte recovery data from the LCSD is assessed in the same way as that of the LCS. The LCSD recoveries, together with the LCS recoveries, are used to determine the reproducibility (precision) of the analytical system. Precision data are expressed as relative percent differences (RPDs). If the RPD fails for an LCS/LCSD and yet the recoveries are within acceptance criteria, the batch is still acceptable.

METHOD BLANK

The Method Blank is a QC sample consisting of all the reagents used in analyzing the environmental samples contained in the QC batch. Method Blank results are used to determine if interference or contamination in the analytical system could lead to the reporting of false positive data or elevated analyte concentrations. All target analytes must be below the reporting limits (RL) or the associated sample(s) must be ND except under the following circumstances:

- Common organic contaminants may be present at concentrations up to 5 times the reporting limits. Common metals contaminants may be present at concentrations up to 2 times the reporting limit, or the reported blank concentration must be twenty fold less than the concentration reported in the associated environmental samples. (See common laboratory contaminants listed in the table.)

<u>Volatile (GC or GC/MS)</u>	<u>Semivolatile (GC/MS)</u>	<u>Metals ICP-MS</u>	<u>Metals ICP Trace</u>
Methylene Chloride, Acetone, 2-Butanone	Phthalate Esters	Copper, Iron, Zinc, Lead, Calcium, Magnesium, Potassium, Sodium, Barium, Chromium, Manganese	Copper, Iron, Zinc, Lead

QUALITY CONTROL ELEMENTS NARRATIVE (continued)

- Organic blanks will be accepted if compounds detected in the blank are present in the associated samples at levels 10 times the blank level. Inorganic blanks will be accepted if elements detected in the blank are present in the associated samples at 20 times the blank level.
- Blanks will be accepted if the compounds/elements detected are not present in any of the associated environmental samples.

Failure to meet these Method Blank criteria requires the reparation and reanalysis of all samples in the QC batch.

MATRIX SPIKE/MATRIX SPIKE DUPLICATE

A Matrix Spike and a Matrix Spike Duplicate are a pair of environmental samples to which known concentrations of a full or partial set of target analytes are added. The MS/MSD results are determined in the same manner as the results of the environmental sample used to prepare the MS/MSD. The analyte recoveries and the relative percent differences (RPDs) of the recoveries are calculated and used to evaluate the effect of the sample matrix on the analytical results. Due to the potential variability of the matrix of each sample, the MS/MSD results may not have an immediate bearing on any samples except the one spiked; therefore, the associated batch MS/MSD may not reflect the same compounds as the samples contained in the analytical report. When these MS/MSD results fail to meet acceptance criteria, the data is evaluated. If the LCS is within acceptance criteria, the batch is considered acceptable.

For certain methods, a Matrix Spike/Sample Duplicate (MS/DU) may be included in the QC batch in place of the MS/MSD. For the parameters (i.e. pH, ignitability) where it is not possible to prepare a spiked sample, a Sample Duplicate may be included in the QC batch. However, a Sample Duplicate is less likely to provide usable precision statistics depending on the likelihood of finding concentrations below the standard reporting limit. When the Sample Duplicate result fails to meet acceptance criteria, the data is evaluated.

For certain methods (600 series methods/CWA), a Matrix Spike is required in place of a Matrix Spike/Matrix Spike Duplicate (MS/MSD) or Matrix Spike/Sample Duplicate (MS/DU).

The acceptance criteria do not apply to samples that are diluted.

SURROGATE COMPOUNDS

In addition to these batch-related QC indicators, each organic environmental and QC sample is spiked with surrogate compounds. Surrogates are organic chemicals that behave similarly to the analytes of interest and that are rarely present in the environment. Surrogate recoveries are used to monitor the individual performance of a sample in the analytical system.

If surrogate recoveries are biased high in the LCS, LCSD, or the Method Blank, and the associated sample(s) are ND, the batch is acceptable. Otherwise, if the LCS, LCSD, or Method Blank surrogate(s) fail to meet recovery criteria, the entire sample batch is reprepared and reanalyzed. If the surrogate recoveries are outside criteria for environmental samples, the samples will be reprepared and reanalyzed unless there is objective evidence of matrix interference or if the sample dilution is greater than the threshold outlined in the associated method SOP.

The acceptance criteria do not apply to samples that are diluted. All other surrogate recoveries will be reported.

For the GC/MS BNA methods, the surrogate criterion is that two of the three surrogates for each fraction must meet acceptance criteria. The third surrogate must have a recovery of ten percent or greater.

For the Pesticide and PCB methods, the surrogate criterion is that one of two surrogate compounds must meet acceptance criteria. The second surrogate must have a recovery of 10% or greater.



TestAmerica Certifications and Approvals:

The laboratory is certified for the analytes listed on the documents below. These are available upon request.
California (#01144CA), Connecticut (#PH-0590), Florida (#E87225),
Illinois (#200004), Kansas (#E10336), Minnesota (#39-999-348), New Jersey (#OH001), New York (#10975), Nevada
(#OH-000482008A), OhioVAP (#CL0024), Pennsylvania (#008), West Virginia (#210), Wisconsin (#999518190), NAVY,
ARMY, USDA Soil Permit

EXECUTIVE SUMMARY - Detection Highlights

A0I290542

PARAMETER	RESULT	REPORTING LIMIT	UNITS	ANALYTICAL METHOD
CRS-MW-MW6A 09/29/10 10:30 001				
Naphthalene	24000	1700	ug/L	SW846 8260B
1,2,4-Trimethylbenzene	400 J	1700	ug/L	SW846 8260B
Benzene	1400 J	1700	ug/L	SW846 8260B
Carbon tetrachloride	980 J	1700	ug/L	SW846 8260B
1,1-Dichloroethane	790 J	1700	ug/L	SW846 8260B
1,2-Dichloroethane	600 J	1700	ug/L	SW846 8260B
cis-1,2-Dichloroethene	59000	1700	ug/L	SW846 8260B
1,1-Dichloroethene	1100 J	1700	ug/L	SW846 8260B
trans-1,3-Dichloropropene	340 J	1700	ug/L	SW846 8260B
Ethylbenzene	330 J	1700	ug/L	SW846 8260B
Methylene chloride	2100 B	1700	ug/L	SW846 8260B
4-Methyl-2-pentanone	750 J	17000	ug/L	SW846 8260B
Toluene	14000	1700	ug/L	SW846 8260B
1,1,1-Trichloroethane	6600	1700	ug/L	SW846 8260B
CRS-MW-MW6B 09/29/10 11:15 002				
Naphthalene	70000	3300	ug/L	SW846 8260B
1,2,4-Trimethylbenzene	1800 J	3300	ug/L	SW846 8260B
1,3,5-Trimethylbenzene	780 J	3300	ug/L	SW846 8260B
Benzene	3400	3300	ug/L	SW846 8260B
1,1-Dichloroethane	1300 J	3300	ug/L	SW846 8260B
cis-1,2-Dichloroethene	110000	3300	ug/L	SW846 8260B
1,1-Dichloroethene	2900 J	3300	ug/L	SW846 8260B
Ethylbenzene	2200 J	3300	ug/L	SW846 8260B
Methylene chloride	3900 B	3300	ug/L	SW846 8260B
Styrene	930 J	3300	ug/L	SW846 8260B
Toluene	80000	3300	ug/L	SW846 8260B
1,1,1-Trichloroethane	23000	3300	ug/L	SW846 8260B
Xylenes (total)	6300 J	6700	ug/L	SW846 8260B
CRS-MW-MW6B (DNAPL) 09/29/10 11:15 003				
Naphthalene	92000000	1000000	ug/kg	SW846 8260B
	Qualifiers: E			
1,2,4-Trimethylbenzene	3400000	1000000	ug/kg	SW846 8260B
1,3,5-Trimethylbenzene	1200000	1000000	ug/kg	SW846 8260B
Benzene	320000 J	530000	ug/kg	SW846 8260B
1,1-Dichloroethene	270000 J	530000	ug/kg	SW846 8260B
cis-1,2-Dichloroethene	4400000	260000	ug/kg	SW846 8260B
Ethylbenzene	2500000	530000	ug/kg	SW846 8260B
Isopropylbenzene	86000 J	1000000	ug/kg	SW846 8260B
Methylcyclohexane	360000 J	530000	ug/kg	SW846 8260B

(Continued on next page)

EXECUTIVE SUMMARY - Detection Highlights

A0I290542

<u>PARAMETER</u>	<u>RESULT</u>	<u>REPORTING LIMIT</u>	<u>UNITS</u>	<u>ANALYTICAL METHOD</u>
CRS-MW-MW6B (DNAPL) 09/29/10 11:15 003				
Styrene	960000	530000	ug/kg	SW846 8260B
Tetrachloroethene	140000 J	530000	ug/kg	SW846 8260B
Toluene	32000000	530000	ug/kg	SW846 8260B
1,1,1-Trichloroethane	4200000	530000	ug/kg	SW846 8260B
Xylenes (total)	7200000	530000	ug/kg	SW846 8260B

ANALYTICAL METHODS SUMMARY

A0I290542

<u>PARAMETER</u>	<u>ANALYTICAL METHOD</u>
Volatile Organics by GC/MS	SW846 8260B

References:

SW846 "Test Methods for Evaluating Solid Waste, Physical/Chemical Methods", Third Edition, November 1986 and its updates.

SAMPLE SUMMARY

A0I290542

WO #	SAMPLE#	CLIENT SAMPLE ID	SAMPLED DATE	SAMP TIME
L7N2X	001	CRS-MW-MW6A	09/29/10	10:30
L7N21	002	CRS-MW-MW6B	09/29/10	11:15
L7N22	003	CRS-MW-MW6B (DNAPL)	09/29/10	11:15

NOTE(S) :

- The analytical results of the samples listed above are presented on the following pages.
- All calculations are performed before rounding to avoid round-off errors in calculated results.
- Results noted as "ND" were not detected at or above the stated limit.
- This report must not be reproduced, except in full, without the written approval of the laboratory.
- Results for the following parameters are never reported on a dry weight basis: color, corrosivity, density, flashpoint, ignitability, layers, odor, paint filter test, pH, porosity pressure, reactivity, redox potential, specific gravity, spot tests, solids, solubility, temperature, viscosity, and weight.

Brown and Caldwell

Client Sample ID: CRS-MW-MW6A

GC/MS Volatiles

Lot-Sample #...: A0I290542-001 Work Order #...: L7N2X1AA Matrix.....: WW
 Date Sampled...: 09/29/10 10:30 Date Received...: 09/29/10
 Prep Date.....: 10/05/10 Analysis Date...: 10/05/10
 Prep Batch #...: 0279231
 Dilution Factor: 1666.67 Method.....: SW846 8260B

PARAMETER	RESULT	REPORTING		
		LIMIT	UNITS	MDL
Naphthalene	24000	1700	ug/L	400
1,2,4-Trimethylbenzene	400 J	1700	ug/L	200
1,3,5-Trimethylbenzene	ND	1700	ug/L	160
Acetone	ND	17000	ug/L	1800
Benzene	1400 J	1700	ug/L	220
Bromodichloromethane	ND	1700	ug/L	250
Bromoform	ND	1700	ug/L	1100
Bromomethane	ND	1700	ug/L	680
2-Butanone	ND	17000	ug/L	950
Carbon disulfide	ND	1700	ug/L	220
Carbon tetrachloride	980 J	1700	ug/L	220
Chlorobenzene	ND	1700	ug/L	250
Dibromochloromethane	ND	1700	ug/L	300
Chloroethane	ND	1700	ug/L	480
Chloroform	ND	1700	ug/L	270
Chloromethane	ND	1700	ug/L	500
Cyclohexane	ND	1700	ug/L	200
1,2-Dibromo-3-chloro- propane	ND	3300	ug/L	1100
1,2-Dibromoethane	ND	1700	ug/L	400
1,2-Dichlorobenzene	ND	1700	ug/L	220
1,3-Dichlorobenzene	ND	1700	ug/L	230
1,4-Dichlorobenzene	ND	1700	ug/L	220
Dichlorodifluoromethane	ND	1700	ug/L	520
1,1-Dichloroethane	790 J	1700	ug/L	250
1,2-Dichloroethane	600 J	1700	ug/L	370
cis-1,2-Dichloroethene	59000	1700	ug/L	280
trans-1,2-Dichloroethene	ND	1700	ug/L	320
1,1-Dichloroethene	1100 J	1700	ug/L	320
1,2-Dichloropropane	ND	1700	ug/L	300
cis-1,3-Dichloropropene	ND	1700	ug/L	230
trans-1,3-Dichloropropene	340 J	1700	ug/L	320
Ethylbenzene	330 J	1700	ug/L	280
2-Hexanone	ND	17000	ug/L	680
Isopropylbenzene	ND	1700	ug/L	220
Methyl acetate	ND	17000	ug/L	630
Methylcyclohexane	ND	1700	ug/L	220
Methylene chloride	2100 B	1700	ug/L	550
4-Methyl-2-pentanone	750 J	17000	ug/L	530

(Continued on next page)

Brown and Caldwell

Client Sample ID: CRS-MW-MW6A

GC/MS Volatiles

Lot-Sample #...: A0I290542-001 Work Order #...: L7N2X1AA Matrix.....: WW

PARAMETER	RESULT	REPORTING		
		LIMIT	UNITS	MDL
Methyl tert-butyl ether	ND	8300	ug/L	280
Styrene	ND	1700	ug/L	180
1,1,2,2-Tetrachloroethane	ND	1700	ug/L	300
Tetrachloroethene	ND	1700	ug/L	480
Toluene	14000	1700	ug/L	220
1,2,4-Trichloro- benzene	ND	1700	ug/L	250
1,1,1-Trichloroethane	6600	1700	ug/L	370
1,1,2-Trichloroethane	ND	1700	ug/L	450
Trichloroethene	ND	1700	ug/L	280
Trichlorofluoromethane	ND	1700	ug/L	350
1,1,2-Trichloro- 1,2,2-trifluoroethane	ND	1700	ug/L	470
Vinyl chloride	ND	1700	ug/L	370
Xylenes (total)	ND	3300	ug/L	470
SURROGATE	PERCENT		RECOVERY	
	RECOVERY	LIMITS		
Dibromofluoromethane	89	(73 - 122)		
1,2-Dichloroethane-d4	98	(61 - 128)		
Toluene-d8	92	(76 - 110)		
4-Bromofluorobenzene	89	(74 - 116)		

NOTE(S):

J Estimated result. Result is less than RL.

B Method blank contamination. The associated method blank contains the target analyte at a reportable level.

Brown and Caldwell

Client Sample ID: CRS-MW-MW6B

GC/MS Volatiles

Lot-Sample #...: A0I290542-002 Work Order #...: L7N211AA Matrix.....: WW
 Date Sampled...: 09/29/10 11:15 Date Received..: 09/29/10
 Prep Date.....: 10/05/10 Analysis Date..: 10/05/10
 Prep Batch #...: 0279231
 Dilution Factor: 3333.33 Method.....: SW846 8260B

PARAMETER	RESULT	REPORTING		
		LIMIT	UNITS	MDL
Naphthalene	70000	3300	ug/L	800
1,2,4-Trimethylbenzene	1800 J	3300	ug/L	400
1,3,5-Trimethylbenzene	780 J	3300	ug/L	320
Acetone	ND	33000	ug/L	3700
Benzene	3400	3300	ug/L	430
Bromodichloromethane	ND	3300	ug/L	500
Bromoform	ND	3300	ug/L	2100
Bromomethane	ND	3300	ug/L	1400
2-Butanone	ND	33000	ug/L	1900
Carbon disulfide	ND	3300	ug/L	430
Carbon tetrachloride	ND	3300	ug/L	430
Chlorobenzene	ND	3300	ug/L	500
Dibromochloromethane	ND	3300	ug/L	600
Chloroethane	ND	3300	ug/L	970
Chloroform	ND	3300	ug/L	530
Chloromethane	ND	3300	ug/L	1000
Cyclohexane	ND	3300	ug/L	400
1,2-Dibromo-3-chloro- propane	ND	6700	ug/L	2200
1,2-Dibromoethane	ND	3300	ug/L	800
1,2-Dichlorobenzene	ND	3300	ug/L	430
1,3-Dichlorobenzene	ND	3300	ug/L	470
1,4-Dichlorobenzene	ND	3300	ug/L	430
Dichlorodifluoromethane	ND	3300	ug/L	1000
1,1-Dichloroethane	1300 J	3300	ug/L	500
1,2-Dichloroethane	ND	3300	ug/L	730
cis-1,2-Dichloroethene	110000	3300	ug/L	570
trans-1,2-Dichloroethene	ND	3300	ug/L	630
1,1-Dichloroethene	2900 J	3300	ug/L	630
1,2-Dichloropropane	ND	3300	ug/L	600
cis-1,3-Dichloropropene	ND	3300	ug/L	470
trans-1,3-Dichloropropene	ND	3300	ug/L	630
Ethylbenzene	2200 J	3300	ug/L	570
2-Hexanone	ND	33000	ug/L	1400
Isopropylbenzene	ND	3300	ug/L	430
Methyl acetate	ND	33000	ug/L	1300
Methylcyclohexane	ND	3300	ug/L	430
Methylene chloride	3900 B	3300	ug/L	1100
4-Methyl-2-pentanone	ND	33000	ug/L	1100

(Continued on next page)

Brown and Caldwell

Client Sample ID: CRS-MW-MW6B

GC/MS Volatiles

Lot-Sample #...: A0I290542-002 Work Order #...: L7N211AA Matrix.....: WW

PARAMETER	RESULT	REPORTING		
		LIMIT	UNITS	MDL
Methyl tert-butyl ether	ND	17000	ug/L	570
Styrene	930 J	3300	ug/L	370
1,1,2,2-Tetrachloroethane	ND	3300	ug/L	600
Tetrachloroethene	ND	3300	ug/L	970
Toluene	80000	3300	ug/L	430
1,2,4-Trichloro-benzene	ND	3300	ug/L	500
1,1,1-Trichloroethane	23000	3300	ug/L	730
1,1,2-Trichloroethane	ND	3300	ug/L	900
Trichloroethene	ND	3300	ug/L	570
Trichlorofluoromethane	ND	3300	ug/L	700
1,1,2-Trichloro-1,2,2-trifluoroethane	ND	3300	ug/L	930
Vinyl chloride	ND	3300	ug/L	730
Xylenes (total)	6300 J	6700	ug/L	930
SURROGATE	PERCENT		RECOVERY	
	RECOVERY	LIMITS		
Dibromofluoromethane	88	(73 - 122)		
1,2-Dichloroethane-d4	99	(61 - 128)		
Toluene-d8	91	(76 - 110)		
4-Bromofluorobenzene	93	(74 - 116)		

NOTE(S):

J Estimated result. Result is less than RL.

B Method blank contamination. The associated method blank contains the target analyte at a reportable level.

Brown and Caldwell

Client Sample ID: CRS-MW-MW6B (DNAPL)

GC/MS Volatiles

Lot-Sample #...: A0I290542-003 Work Order #...: L7N221AA Matrix.....: LO
 Date Sampled...: 09/29/10 11:15 Date Received...: 09/29/10
 Prep Date.....: 10/09/10 Analysis Date...: 10/12/10
 Prep Batch #...: 0285338
 Dilution Factor: 854.29
 % Moisture.....: Method.....: SW846 8260B

PARAMETER	RESULT	REPORTING		
		LIMIT	UNITS	MDL
Naphthalene	92000000 E	1000000	ug/kg	8500
1,2,4-Trimethylbenzene	3400000	1000000	ug/kg	22000
1,3,5-Trimethylbenzene	1200000	1000000	ug/kg	21000
Acetone	ND	2100000	ug/kg	85000
Benzene	320000 J	530000	ug/kg	5500
Bromodichloromethane	ND	530000	ug/kg	10000
Bromoform	ND	530000	ug/kg	11000
Bromomethane	ND	1000000	ug/kg	21000
2-Butanone	ND	2100000	ug/kg	42000
Carbon disulfide	ND	530000	ug/kg	17000
Carbon tetrachloride	ND	530000	ug/kg	10000
Chlorobenzene	ND	530000	ug/kg	5400
Chloroethane	ND	1000000	ug/kg	56000
Chloroform	ND	530000	ug/kg	10000
Chloromethane	ND	1000000	ug/kg	4400
Cyclohexane	ND	2100000	ug/kg	6600
Dibromochloromethane	ND	530000	ug/kg	5900
1,2-Dibromo-3-chloro- propane	ND	1000000	ug/kg	51000
1,2-Dibromoethane	ND	530000	ug/kg	8500
1,2-Dichlorobenzene	ND	1000000	ug/kg	15000
1,3-Dichlorobenzene	ND	1000000	ug/kg	6200
1,4-Dichlorobenzene	ND	1000000	ug/kg	6700
Dichlorodifluoromethane	ND	1000000	ug/kg	4600
1,1-Dichloroethane	ND	530000	ug/kg	6200
1,2-Dichloroethane	ND	530000	ug/kg	7900
1,1-Dichloroethene	270000 J	530000	ug/kg	7100
cis-1,2-Dichloroethene	4400000	260000	ug/kg	12000
trans-1,2-Dichloroethene	ND	260000	ug/kg	9400
1,2-Dichloropropane	ND	530000	ug/kg	6300
cis-1,3-Dichloropropene	ND	530000	ug/kg	4700
trans-1,3-Dichloropropene	ND	530000	ug/kg	4600
Ethylbenzene	2500000	530000	ug/kg	5800
2-Hexanone	ND	2100000	ug/kg	21000
Isopropylbenzene	86000 J	1000000	ug/kg	4400
Methyl acetate	ND	1000000	ug/kg	44000
Methylene chloride	ND	530000	ug/kg	85000
Methylcyclohexane	360000 J	530000	ug/kg	7600

(Continued on next page)

Brown and Caldwell

Client Sample ID: CRS-MW-MW6B (DNAPL)

GC/MS Volatiles

Lot-Sample #...: A0I290542-003 Work Order #...: L7N221AA Matrix.....: LO

PARAMETER	RESULT	REPORTING		
		LIMIT	UNITS	MDL
4-Methyl-2-pentanone	ND	2100000	ug/kg	9400
Methyl tert-butyl ether	ND	2100000	ug/kg	8500
Styrene	960000	530000	ug/kg	24000
1,1,2,2-Tetrachloroethane	ND	530000	ug/kg	7000
Tetrachloroethene	140000 J	530000	ug/kg	7700
Toluene	32000000	530000	ug/kg	7800
1,2,4-Trichloro-benzene	ND	1000000	ug/kg	10000
1,1,1-Trichloroethane	4200000	530000	ug/kg	8100
1,1,2-Trichloroethane	ND	530000	ug/kg	8500
Trichloroethene	ND	530000	ug/kg	10000
Trichlorofluoromethane	ND	1000000	ug/kg	7100
1,1,2-Trichloro-1,2,2-trifluoroethane	ND	2100000	ug/kg	8500
Vinyl chloride	ND	1000000	ug/kg	14000
Xylenes (total)	7200000	530000	ug/kg	13000
SURROGATE	PERCENT		RECOVERY	
	RECOVERY		LIMITS	
Dibromofluoromethane	0.0 DIL, *		(59 - 138)	
1,2-Dichloroethane-d4	0.0 DIL, *		(61 - 130)	
Toluene-d8	0.0 DIL, *		(60 - 143)	
4-Bromofluorobenzene	0.0 DIL, *		(47 - 158)	

NOTE(S):

DIL The concentration is estimated or not reported due to dilution or the presence of interfering analytes.

* Surrogate recovery is outside stated control limits.

E Estimated result. Result concentration exceeds the calibration range.

J Estimated result. Result is less than RL.

QUALITY CONTROL SECTION

METHOD BLANK REPORT

GC/MS Volatiles

Client Lot #...: A0I290542
MB Lot-Sample #: A0J060000-231

Work Order #...: L72VN1AA

Matrix.....: WATER

Analysis Date...: 10/05/10

Prep Date.....: 10/05/10

Prep Batch #...: 0279231

Dilution Factor: 1

PARAMETER	RESULT	REPORTING			METHOD
		LIMIT	UNITS		
Naphthalene	ND	1.0	ug/L	SW846	8260B
1,2,4-Trimethylbenzene	ND	1.0	ug/L	SW846	8260B
1,3,5-Trimethylbenzene	ND	1.0	ug/L	SW846	8260B
Acetone	ND	10	ug/L	SW846	8260B
Benzene	ND	1.0	ug/L	SW846	8260B
Bromodichloromethane	ND	1.0	ug/L	SW846	8260B
Bromoform	ND	1.0	ug/L	SW846	8260B
Bromomethane	ND	1.0	ug/L	SW846	8260B
2-Butanone	ND	10	ug/L	SW846	8260B
Carbon disulfide	ND	1.0	ug/L	SW846	8260B
Carbon tetrachloride	ND	1.0	ug/L	SW846	8260B
Chlorobenzene	ND	1.0	ug/L	SW846	8260B
Dibromochloromethane	ND	1.0	ug/L	SW846	8260B
Chloroethane	ND	1.0	ug/L	SW846	8260B
Chloroform	ND	1.0	ug/L	SW846	8260B
Chloromethane	ND	1.0	ug/L	SW846	8260B
Cyclohexane	ND	1.0	ug/L	SW846	8260B
1,2-Dibromo-3-chloro-propane	ND	2.0	ug/L	SW846	8260B
1,2-Dibromoethane	ND	1.0	ug/L	SW846	8260B
1,2-Dichlorobenzene	ND	1.0	ug/L	SW846	8260B
1,3-Dichlorobenzene	ND	1.0	ug/L	SW846	8260B
1,4-Dichlorobenzene	ND	1.0	ug/L	SW846	8260B
Dichlorodifluoromethane	ND	1.0	ug/L	SW846	8260B
1,1-Dichloroethane	ND	1.0	ug/L	SW846	8260B
1,2-Dichloroethane	ND	1.0	ug/L	SW846	8260B
cis-1,2-Dichloroethene	ND	1.0	ug/L	SW846	8260B
trans-1,2-Dichloroethene	ND	1.0	ug/L	SW846	8260B
1,1-Dichloroethene	ND	1.0	ug/L	SW846	8260B
1,2-Dichloropropane	ND	1.0	ug/L	SW846	8260B
cis-1,3-Dichloropropene	ND	1.0	ug/L	SW846	8260B
trans-1,3-Dichloropropene	ND	1.0	ug/L	SW846	8260B
Ethylbenzene	ND	1.0	ug/L	SW846	8260B
2-Hexanone	ND	10	ug/L	SW846	8260B
Isopropylbenzene	ND	1.0	ug/L	SW846	8260B
Methyl acetate	ND	10	ug/L	SW846	8260B
Methylcyclohexane	ND	1.0	ug/L	SW846	8260B
Methylene chloride	0.44 J	1.0	ug/L	SW846	8260B
4-Methyl-2-pentanone	ND	10	ug/L	SW846	8260B
Methyl tert-butyl ether	ND	5.0	ug/L	SW846	8260B
Styrene	ND	1.0	ug/L	SW846	8260B

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METHOD BLANK REPORT

GC/MS Volatiles

Client Lot #...: A0I290542

Work Order #...: L72VN1AA

Matrix.....: WATER

PARAMETER	RESULT	REPORTING		METHOD
		LIMIT	UNITS	
1,1,2,2-Tetrachloroethane	ND	1.0	ug/L	SW846 8260B
Tetrachloroethene	ND	1.0	ug/L	SW846 8260B
Toluene	ND	1.0	ug/L	SW846 8260B
1,2,4-Trichloro-benzene	ND	1.0	ug/L	SW846 8260B
1,1,1-Trichloroethane	ND	1.0	ug/L	SW846 8260B
1,1,2-Trichloroethane	ND	1.0	ug/L	SW846 8260B
Trichloroethene	ND	1.0	ug/L	SW846 8260B
Trichlorofluoromethane	ND	1.0	ug/L	SW846 8260B
1,1,2-Trichloro-1,2,2-trifluoroethane	ND	1.0	ug/L	SW846 8260B
Vinyl chloride	ND	1.0	ug/L	SW846 8260B
Xylenes (total)	ND	2.0	ug/L	SW846 8260B

SURROGATE	PERCENT	RECOVERY
	RECOVERY	LIMITS
Dibromofluoromethane	89	(73 - 122)
1,2-Dichloroethane-d4	99	(61 - 128)
Toluene-d8	94	(76 - 110)
4-Bromofluorobenzene	89	(74 - 116)

NOTE(S):

Calculations are performed before rounding to avoid round-off errors in calculated results.

J Estimated result. Result is less than RL.

METHOD BLANK REPORT

GC/MS Volatiles

Client Lot #...: A0I290542
MB Lot-Sample #: A0J120000-338

Work Order #...: L8CNH1AA

Matrix.....: WASTE

Analysis Date...: 10/12/10

Prep Date.....: 10/09/10

Prep Batch #...: 0285338

Dilution Factor: 1

PARAMETER	RESULT	REPORTING			METHOD
		LIMIT	UNITS		
Naphthalene	ND	1200	ug/kg	SW846	8260B
1,2,4-Trimethylbenzene	ND	1200	ug/kg	SW846	8260B
1,3,5-Trimethylbenzene	ND	1200	ug/kg	SW846	8260B
Acetone	ND	2500	ug/kg	SW846	8260B
Benzene	ND	620	ug/kg	SW846	8260B
Bromodichloromethane	ND	620	ug/kg	SW846	8260B
Bromoform	ND	620	ug/kg	SW846	8260B
Bromomethane	ND	1200	ug/kg	SW846	8260B
2-Butanone	ND	2500	ug/kg	SW846	8260B
Carbon disulfide	ND	620	ug/kg	SW846	8260B
Carbon tetrachloride	ND	620	ug/kg	SW846	8260B
Chlorobenzene	ND	620	ug/kg	SW846	8260B
Chloroethane	ND	1200	ug/kg	SW846	8260B
Chloroform	ND	620	ug/kg	SW846	8260B
Chloromethane	ND	1200	ug/kg	SW846	8260B
Cyclohexane	ND	2500	ug/kg	SW846	8260B
Dibromochloromethane	ND	620	ug/kg	SW846	8260B
1,2-Dibromo-3-chloro- propane	ND	1200	ug/kg	SW846	8260B
1,2-Dibromoethane	ND	620	ug/kg	SW846	8260B
1,2-Dichlorobenzene	ND	1200	ug/kg	SW846	8260B
1,3-Dichlorobenzene	ND	1200	ug/kg	SW846	8260B
1,4-Dichlorobenzene	ND	1200	ug/kg	SW846	8260B
Dichlorodifluoromethane	ND	1200	ug/kg	SW846	8260B
1,1-Dichloroethane	ND	620	ug/kg	SW846	8260B
1,2-Dichloroethane	ND	620	ug/kg	SW846	8260B
1,1-Dichloroethene	ND	620	ug/kg	SW846	8260B
cis-1,2-Dichloroethene	ND	310	ug/kg	SW846	8260B
trans-1,2-Dichloroethene	ND	310	ug/kg	SW846	8260B
1,2-Dichloropropane	ND	620	ug/kg	SW846	8260B
cis-1,3-Dichloropropene	ND	620	ug/kg	SW846	8260B
trans-1,3-Dichloropropene	ND	620	ug/kg	SW846	8260B
Ethylbenzene	ND	620	ug/kg	SW846	8260B
2-Hexanone	ND	2500	ug/kg	SW846	8260B
Isopropylbenzene	ND	1200	ug/kg	SW846	8260B
Methyl acetate	ND	1200	ug/kg	SW846	8260B
Methylene chloride	ND	620	ug/kg	SW846	8260B
Methylcyclohexane	ND	620	ug/kg	SW846	8260B
4-Methyl-2-pentanone	ND	2500	ug/kg	SW846	8260B
Methyl tert-butyl ether	ND	2500	ug/kg	SW846	8260B
Styrene	ND	620	ug/kg	SW846	8260B

(Continued on next page)

METHOD BLANK REPORT

GC/MS Volatiles

Client Lot #...: A0I290542

Work Order #...: L8CNH1AA

Matrix.....: WASTE

PARAMETER	RESULT	REPORTING			METHOD
		LIMIT	UNITS		
1,1,2,2-Tetrachloroethane	ND	620	ug/kg	SW846	8260B
Tetrachloroethene	ND	620	ug/kg	SW846	8260B
Toluene	ND	620	ug/kg	SW846	8260B
1,2,4-Trichloro- benzene	65 J	1200	ug/kg	SW846	8260B
1,1,1-Trichloroethane	ND	620	ug/kg	SW846	8260B
1,1,2-Trichloroethane	ND	620	ug/kg	SW846	8260B
Trichloroethene	ND	620	ug/kg	SW846	8260B
Trichlorofluoromethane	ND	1200	ug/kg	SW846	8260B
1,1,2-Trichloro- 1,2,2-trifluoroethane	ND	2500	ug/kg	SW846	8260B
Vinyl chloride	ND	1200	ug/kg	SW846	8260B
Xylenes (total)	ND	620	ug/kg	SW846	8260B

SURROGATE	PERCENT	RECOVERY
	RECOVERY	LIMITS
Dibromofluoromethane	86	(36 - 132)
1,2-Dichloroethane-d4	105	(55 - 120)
Toluene-d8	97	(29 - 132)
4-Bromofluorobenzene	87	(27 - 136)

NOTE(S):

Calculations are performed before rounding to avoid round-off errors in calculated results.

J Estimated result. Result is less than RL.

LABORATORY CONTROL SAMPLE EVALUATION REPORT

GC/MS Volatiles

Client Lot #...: A0I290542 Work Order #...: L72VN1AC-LCS Matrix.....: WATER
 LCS Lot-Sample#: A0J060000-231 L72VN1AD-LCSD
 Prep Date.....: 10/05/10 Analysis Date...: 10/05/10
 Prep Batch #...: 0279231
 Dilution Factor: 1

PARAMETER	PERCENT RECOVERY	RECOVERY LIMITS	RPD	RPD LIMITS	METHOD
Benzene	109	(80 - 116)			SW846 8260B
	109	(80 - 116)	0.60	(0-20)	SW846 8260B
Chlorobenzene	109	(76 - 117)			SW846 8260B
	105	(76 - 117)	3.0	(0-20)	SW846 8260B
1,1-Dichloroethene	94	(63 - 130)			SW846 8260B
	95	(63 - 130)	0.12	(0-20)	SW846 8260B
Toluene	112	(74 - 119)			SW846 8260B
	110	(74 - 119)	1.6	(0-20)	SW846 8260B
Trichloroethene	97	(75 - 122)			SW846 8260B
	97	(75 - 122)	0.12	(0-20)	SW846 8260B

SURROGATE	PERCENT RECOVERY	RECOVERY LIMITS
Dibromofluoromethane	89	(73 - 122)
	88	(73 - 122)
1,2-Dichloroethane-d4	103	(61 - 128)
	105	(61 - 128)
Toluene-d8	95	(76 - 110)
	95	(76 - 110)
4-Bromofluorobenzene	104	(74 - 116)
	103	(74 - 116)

NOTE(S):

Calculations are performed before rounding to avoid round-off errors in calculated results.
 Bold print denotes control parameters

LABORATORY CONTROL SAMPLE EVALUATION REPORT

GC/MS Volatiles

Client Lot #...: A0I290542 Work Order #...: L8CNH1AC-LCS Matrix.....: WASTE
 LCS Lot-Sample#: A0J120000-338 L8CNH1AD-LCSD
 Prep Date.....: 10/09/10 Analysis Date...: 10/12/10
 Prep Batch #...: 0285338
 Dilution Factor: 1

PARAMETER	PERCENT RECOVERY	RECOVERY LIMITS	RPD	RPD LIMITS	METHOD
Benzene	104	(72 - 122)			SW846 8260B
	102	(72 - 122)	2.2	(0-20)	SW846 8260B
Chlorobenzene	96	(74 - 121)			SW846 8260B
	101	(74 - 121)	4.8	(0-30)	SW846 8260B
1,1-Dichloroethene	108	(44 - 150)			SW846 8260B
	108	(44 - 150)	0.050	(0-30)	SW846 8260B
Toluene	101	(70 - 124)			SW846 8260B
	105	(70 - 124)	3.9	(0-30)	SW846 8260B
Trichloroethene	95	(63 - 131)			SW846 8260B
	102	(63 - 131)	7.1	(0-30)	SW846 8260B

SURROGATE	PERCENT RECOVERY	RECOVERY LIMITS
Dibromofluoromethane	83	(36 - 132)
	84	(36 - 132)
1,2-Dichloroethane-d4	97	(55 - 120)
	99	(55 - 120)
Toluene-d8	94	(29 - 132)
	91	(29 - 132)
4-Bromofluorobenzene	90	(27 - 136)
	88	(27 - 136)

NOTE(S):

Calculations are performed before rounding to avoid round-off errors in calculated results.
 Bold print denotes control parameters

MATRIX SPIKE SAMPLE EVALUATION REPORT

GC/MS Volatiles

Client Lot #...: A0I290542 Work Order #...: L7RLT1AC-MS Matrix.....: WATER
 MS Lot-Sample #: A0I300564-012 L7RLT1AD-MSD
 Date Sampled...: 09/29/10 13:00 Date Received...: 09/30/10
 Prep Date.....: 10/05/10 Analysis Date...: 10/05/10
 Prep Batch #...: 0279231
 Dilution Factor: 500

PARAMETER	PERCENT RECOVERY	RECOVERY LIMITS	RPD	RPD LIMITS	METHOD
Benzene	114	(78 - 118)			SW846 8260B
	128 a	(78 - 118)	3.6	(0-20)	SW846 8260B
Chlorobenzene	101	(76 - 117)			SW846 8260B
	105	(76 - 117)	4.0	(0-20)	SW846 8260B
1,1-Dichloroethene	92	(62 - 130)			SW846 8260B
	91	(62 - 130)	0.88	(0-20)	SW846 8260B
Toluene	105	(70 - 119)			SW846 8260B
	108	(70 - 119)	2.8	(0-20)	SW846 8260B
Trichloroethene	93	(62 - 130)			SW846 8260B
	96	(62 - 130)	3.0	(0-20)	SW846 8260B

SURROGATE	PERCENT RECOVERY	RECOVERY LIMITS
Dibromofluoromethane	91	(73 - 122)
	88	(73 - 122)
1,2-Dichloroethane-d4	108	(61 - 128)
	105	(61 - 128)
Toluene-d8	95	(76 - 110)
	94	(76 - 110)
4-Bromofluorobenzene	101	(74 - 116)
	102	(74 - 116)

NOTE(S):

Calculations are performed before rounding to avoid round-off errors in calculated results.

Bold print denotes control parameters

a Spiked analyte recovery is outside stated control limits.

BROWN AND
CALDWELL

☐ Cincinnati Office

135 Merchant St Suite 240

Cincinnati, Ohio 45246

(513) 719-6100

(513) 719-6105 fax

Lab Quote No:

Test America

Address:

CHURCHILL AVE.

North Canyon, off

4101 Shattuck St. NW
North Canton, OH
Phone: 44720

Carrier: **FED EX**

~~Hand Delivery~~

85575590 25550

Remarks:

Note all samples have some NADH component. We want analysis of the L NADH the DNAP and the water (3 results total)

BROWN AND
CALDWELL

☐ Cincinnati Office

135 Merchant St Suite 240

Cincinnati, Ohio 45246

(513) 719-6100

(513) 719-6105 fax

Lab Quote No:

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Carrier: **FED EX**

~~Hand Delivery~~

85575590 25550

Remarks:

Note all samples have some NADH component. We want analysis of the L NADH the DNAP and the water (3 results total)

[illegible]

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TestAmerica Cooler Receipt Form/Narrative

Lot Number: AOI290542

North Canton Facility

Client Brown Caldwell Project CBS Elyria By J. Smith
Cooler Received on 9-29-10 Opened on 9-29-10 (Signature)

FedEx ☐ UPS ☐ DHL ☐ FAS ☐ Stetson ☐ Client Drop Off ☒ TestAmerica Courier ☐ Other ☐
TestAmerica Cooler # _____ Multiple Coolers ☐ Foam Box ☐ Client Cooler ☒ Other ☐

1. Were custody seals on the outside of the cooler(s)? Yes ☐ No ☒ Intact? Yes ☐ No ☒ NA ☒
If YES, Quantity _____ Quantity Unsalvageable _____
Were custody seals on the outside of cooler(s) signed and dated? Yes ☐ No ☐ NA ☒
Were custody seals on the bottle(s)? Yes ☐ No ☒
If YES, are there any exceptions? _____
 2. Shippers' packing slip attached to the cooler(s)? Yes ☐ No ☒
 3. Did custody papers accompany the sample(s)? Yes ☒ No ☐ Relinquished by client? Yes ☒ No ☐
 4. Were the custody papers signed in the appropriate place? Yes ☒ No ☐
 5. Packing material used: Bubble Wrap ☐ Foam ☒ None ☐ Other _____
 6. Cooler temperature upon receipt 9.8 °C See back of form for multiple coolers/temps ☐
METHOD: IR ☒ Other ☐
COOLANT: Wet Ice ☒ Blue Ice ☐ Dry Ice ☐ Water ☐ None ☐
 7. Did all bottles arrive in good condition (Unbroken)? Yes ☒ No ☐
 8. Could all bottle labels be reconciled with the COC? Yes ☒ No ☐
 9. Were sample(s) at the correct pH upon receipt? Yes ☐ No ☐ NA ☒
 10. Were correct bottle(s) used for the test(s) indicated? Yes ☒ No ☐
 11. Were air bubbles >6 mm in any VOA vials? Yes ☐ No ☒ NA ☐
 12. Sufficient quantity received to perform indicated analyses? Yes ☒ No ☐
 13. Was a trip blank present in the cooler(s)? Yes ☐ No ☒ Were VOAs on the COC? Yes ☒ No ☐
- Contacted PM AND Date 9-29-10 by gal via Verbal ☒ Voice Mail ☐ Other ☐
Concerning high temp

14. CHAIN OF CUSTODY

The following discrepancies occurred:

- High temp - direct from field.

15. SAMPLE CONDITION

- Sample(s) _____ were received after the recommended holding time had expired.
Sample(s) _____ were received in a broken container.
Sample(s) _____ were received with bubble >6 mm in diameter. (Notify PM)

16. SAMPLE PRESERVATION

Sample(s) _____ were further preserved in Sample Receiving to meet recommended pH level(s). Nitric Acid Lot# 051010-HNO₃; Sulfuric Acid Lot# 051010-H₂SO₄; Sodium Hydroxide Lot# 100108 -NaOH; Hydrochloric Acid Lot# 092006-HCl; Sodium Hydroxide and Zinc Acetate Lot# 100108-(CH₃COO)₂ZN/NaOH. What time was preservative added to sample(s)? _____

Client ID	pH	Date	Initials

North Canton Facility

[illegible]

Discrepancies Cont'd:

END OF REPORT

ANALYTICAL REPORT

PROJECT NO. 139452

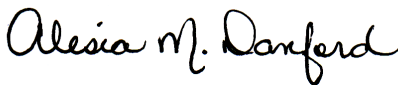
CRS ELYRIA

Lot #: A0K230408

James A. Peeples

Brown and Caldwell
4700 Lakehurst Court
Suite 100
Dublin, OH 43016

TESTAMERICA LABORATORIES, INC.



Alesia M. Danford
Project Manager
alesia.danford@testamericainc.com

Approved for release.
Alesia M. Danford
Project Manager
12/21/2010 5:04 PM

December 21, 2010

TestAmerica Laboratories, Inc.

TestAmerica North Canton 4101 Shuffel Street NW, North Canton, OH 44720

Tel (330)497-9396 Fax (330)497-0772 www.testamericainc.com



CASE NARRATIVE

A0K230408

The following report contains the analytical results for nine solid samples, one waste sample and one water sample submitted to TestAmerica North Canton by Brown & Caldwell from the CRS ELYRIA Site, project number 139452. The samples were received November 20, 2010, according to documented sample acceptance procedures.

TestAmerica utilizes USEPA approved methods in all analytical work. The samples presented in this report were analyzed for the parameter(s) listed on the analytical methods summary page in accordance with the method(s) indicated. Preliminary results were provided to James A. Peeples on December 09, 2010 and December 16, 2010. A summary of QC data for these analyses is included at the back of the report.

TestAmerica North Canton attests to the validity of the laboratory data generated by TestAmerica facilities reported herein. All analyses performed by TestAmerica facilities were done using established laboratory SOPs that incorporate QA/QC procedures described in the applicable methods. TestAmerica's operations groups have reviewed the data for compliance with the laboratory QA/QC plan, and data have been found to be compliant with laboratory protocols unless otherwise noted below.

All solid sample results are reported on an "as received" basis unless otherwise indicated by a dry weight adjustment footnote at the bottom of the analytical report page. The list of parameters which are never reported on a dry weight basis is included on the Sample Summary.

The test results in this report meet all NELAP requirements for parameters for which accreditation is required or available. Any exceptions to NELAP requirements are noted in this report. Pursuant to NELAP, this report may not be reproduced, except in full, without the written approval of the laboratory. This laboratory report is confidential and is intended for the sole use of TestAmerica and its client.

All parameters were evaluated to the method detection limit and include qualified results where applicable.

Please refer to the Quality Control Elements Narrative following this case narrative for additional quality control information.

If you have any questions, please call the Project Manager, Alesia M. Danford, at 330-497-9396.

CASE NARRATIVE (continued)

This report is sequentially paginated. The final page of the report is labeled as "END OF REPORT."

SUPPLEMENTAL QC INFORMATION

SAMPLE RECEIVING

The temperatures of the coolers upon sample receipt were 2.8 and 3.5°C.

Sample(s) MW-6, MW-6 DNAPL, GP-57, 4-8', GP-56, 8-9', GP-54, 4-8' and GP-47, 4-6' were collected 11/16/10, 11/17/10, and 11/19/10. The samples were received 11/20/10. The tests were added and analyzed outside of method holding times.

See TestAmerica's Cooler Receipt Form for additional information.

GC/MS VOLATILES

The sample(s) that contained concentrations of target analyte(s) at a reportable level in the associated Method Blank(s) were flagged with "B". All target analytes in the Method Blank must be below the reporting limit (RL) or the associated sample(s) must be ND with the exception of common laboratory contaminants.

The sample(s) that contain results between the MDL and the RL were flagged with "J". There is a possibility of false positive or mis-identification at these quantitation levels. In analytical methods requiring confirmation of the analyte reported, confirmation was performed only down to the standard reporting limit (SRL). The acceptance criteria for QC samples may not be met at these quantitation levels.

There were no client requested Matrix Spike/Matrix Spike Duplicate (MS/MSD) samples in batch(es) 0336449 and 0342315. Therefore, the laboratory has included a Laboratory Control Sample Duplicate (LCSD) in the QC batch. The LCSD recoveries, together with the LCS recoveries, are used to determine the reproducibility (precision) of the analytical system.

The LNAPL layer for sample(s) MW-6 DNAPL consisted of a black coating adhering to the top inside of the sample container. The sample was prepped by wiping the top inside of the sample jar with 3 Q-tips. The Q-tips were weighed before the wiping was done to establish tare weights, and weighed afterward to get a sample weight. The 3 Q-tips were then extracted with methanol. An aliquot of the methanol extract will be used for analysis.

CASE NARRATIVE (continued)

GC/MS SEMIVOLATILES

The sample(s) that contained concentrations of target analyte(s) at a reportable level in the associated Method Blank(s) were flagged with "B". All target analytes in the Method Blank must be below the reporting limit (RL) or the associated sample(s) must be ND with the exception of common laboratory contaminants.

The sample(s) that contain results between the MDL and the RL were flagged with "J". There is a possibility of false positive or mis-identification at these quantitation levels. In analytical methods requiring confirmation of the analyte reported, confirmation was performed only down to the standard reporting limit (SRL). The acceptance criteria for QC samples may not be met at these quantitation levels.

The matrix spike/matrix spike duplicate(s) for GP-74, 12-16' had RPD's and recoveries outside acceptance limits. However, since the associated method blank(s) and laboratory control sample(s) were in control, no corrective action was necessary.

The matrix spike/matrix spike duplicate(s) for batch(es) 0335034 had recoveries outside acceptance limits. However, since the associated method blank(s) and laboratory control sample(s) were in control, no corrective action was necessary.

There were no client requested Matrix Spike/Matrix Spike Duplicate (MS/MSD) samples in batch(es) 0329024 and 0336061. Therefore, the laboratory has included a Laboratory Control Sample Duplicate (LCSD) in the QC batch. The LCSD recoveries, together with the LCS recoveries, are used to determine the reproducibility (precision) of the analytical system.

The matrix spike/matrix spike duplicate performed in batch(es) 0335034 on another client's sample appeared to have not been spiked. It was reextracted and met QC criteria, but that reextract batch is not associated with this lot.

Sample GP-80, 12-15' had elevated reporting limits due to matrix interferences.

Batch(es) 0329024 had RPDs outside QC criteria in the LCS/LCSD, but recoveries were within QC criteria; therefore, no corrective action was required.

POLYCHLORINATED BIPHENYLS-8082

The matrix spike/matrix spike duplicate(s) for batch(es) 0336049 had RPD's and recoveries outside acceptance limits. However, since the associated method blank(s) and laboratory control sample(s) were in control, no corrective action was necessary.

CASE NARRATIVE (continued)

POLYCHLORINATED BIPHENYLS-8082 (continued)

There were no client requested Matrix Spike/Matrix Spike Duplicate (MS/MSD) samples in batch(es) 0336047. Therefore, the laboratory has included a Laboratory Control Sample Duplicate (LCSD) in the QC batch. The LCSD recoveries, together with the LCS recoveries, are used to determine the reproducibility (precision) of the analytical system.

Batch(es) 0336047 had RPD's outside QC criteria in the LCS/LCSD, but recoveries were within QC criteria; therefore, no corrective action was necessary.

Surrogate recoveries were outside criteria for sample(s) GP-47, 4-6'. Since the method criterion is that one of two surrogate compounds must meet acceptance criteria, no corrective action was required.

Sample(s) GP-47, 4-6' had elevated reporting limits due to matrix interference that routine clean-up techniques could not remove.

GENERAL CHEMISTRY

The analytical results met the requirements of the laboratory's QA/QC program.

QUALITY CONTROL ELEMENTS NARRATIVE

TestAmerica conducts a quality assurance/quality control (QA/QC) program designed to provide scientifically valid and legally defensible data. Toward this end, several types of quality control indicators are incorporated into the QA/QC program, which is described in detail in QA Policy, QA-003. These indicators are introduced into the sample testing process to provide a mechanism for the assessment of the analytical data. Program or agency specific requirements take precedence over the requirements listed in this narrative.

QC BATCH

Environmental samples are taken through the testing process in groups called QUALITY CONTROL BATCHES (QC batches). A QC batch contains up to twenty environmental samples of a similar matrix (water, soil) that are processed using the same reagents and standards. TestAmerica North Canton requires that each environmental sample be associated with a QC batch.

Several quality control samples are included in each QC batch and are processed identically to the twenty environmental samples.

For SW846/RCRA methods, QC samples include a METHOD BLANK (MB), a LABORATORY CONTROL SAMPLE (LCS) and, where appropriate, a MATRIX SPIKE/MATRIX SPIKE DUPLICATE (MS/MSD) pair or a MATRIX SPIKE/SAMPLE DUPLICATE (MS/DU) pair. If there is insufficient sample to perform an MS/MSD or an MS/DU, then a LABORATORY CONTROL SAMPLE DUPLICATE (LCSD) is included in the QC batch.

For 600 series/CWA methods, QC samples include a METHOD BLANK (MB), a LABORATORY CONTROL SAMPLE (LCS) and, where appropriate, a MATRIX SPIKE (MS). An MS is prepared and analyzed at a 10% frequency for GC Methods and at a 5% frequency for GC/MS methods.

LABORATORY CONTROL SAMPLE

The Laboratory Control Sample is a QC sample that is created by adding known concentrations of a full or partial set of target analytes to a matrix similar to that of the environmental samples in the QC batch. Multi peak responders may not be included in the target spike list due to co-elution. The LCS analyte recovery results are used to monitor the analytical process and provide evidence that the laboratory is performing the method within acceptable guidelines. All control analytes indicated by a bold type in the LCS must meet acceptance criteria. Failure to meet the established recovery guidelines requires the reparation and reanalysis of all samples in the QC batch. Comparison of only the failed parameters from the first batch are evaluated. The only exception to the rework requirement is that if the LCS recoveries are biased high and the associated sample is ND (non-detected) for the parameter(s) of interest, the batch is acceptable.

At times, a Laboratory Control Sample Duplicate (LCSD) is also included in the QC batch. An LCSD is a QC sample that is created and handled identically to the LCS. Analyte recovery data from the LCSD is assessed in the same way as that of the LCS. The LCSD recoveries, together with the LCS recoveries, are used to determine the reproducibility (precision) of the analytical system. Precision data are expressed as relative percent differences (RPDs). If the RPD fails for an LCS/LCSD and yet the recoveries are within acceptance criteria, the batch is still acceptable.

METHOD BLANK

The Method Blank is a QC sample consisting of all the reagents used in analyzing the environmental samples contained in the QC batch. Method Blank results are used to determine if interference or contamination in the analytical system could lead to the reporting of false positive data or elevated analyte concentrations. All target analytes must be below the reporting limits (RL) or the associated sample(s) must be ND except under the following circumstances:

- Common organic contaminants may be present at concentrations up to 5 times the reporting limits. Common metals contaminants may be present at concentrations up to 2 times the reporting limit, or the reported blank concentration must be twenty fold less than the concentration reported in the associated environmental samples. (See common laboratory contaminants listed in the table.)

<u>Volatile (GC or GC/MS)</u>	<u>Semivolatile (GC/MS)</u>	<u>Metals ICP-MS</u>	<u>Metals ICP Trace</u>
Methylene Chloride, Acetone, 2-Butanone	Phthalate Esters	Copper, Iron, Zinc, Lead, Calcium, Magnesium, Potassium, Sodium, Barium, Chromium, Manganese	Copper, Iron, Zinc, Lead

QUALITY CONTROL ELEMENTS NARRATIVE (continued)

- Organic blanks will be accepted if compounds detected in the blank are present in the associated samples at levels 10 times the blank level. Inorganic blanks will be accepted if elements detected in the blank are present in the associated samples at 20 times the blank level.
- Blanks will be accepted if the compounds/elements detected are not present in any of the associated environmental samples.

Failure to meet these Method Blank criteria requires the reparation and reanalysis of all samples in the QC batch.

MATRIX SPIKE/MATRIX SPIKE DUPLICATE

A Matrix Spike and a Matrix Spike Duplicate are a pair of environmental samples to which known concentrations of a full or partial set of target analytes are added. The MS/MSD results are determined in the same manner as the results of the environmental sample used to prepare the MS/MSD. The analyte recoveries and the relative percent differences (RPDs) of the recoveries are calculated and used to evaluate the effect of the sample matrix on the analytical results. Due to the potential variability of the matrix of each sample, the MS/MSD results may not have an immediate bearing on any samples except the one spiked; therefore, the associated batch MS/MSD may not reflect the same compounds as the samples contained in the analytical report. When these MS/MSD results fail to meet acceptance criteria, the data is evaluated. If the LCS is within acceptance criteria, the batch is considered acceptable.

For certain methods, a Matrix Spike/Sample Duplicate (MS/DU) may be included in the QC batch in place of the MS/MSD. For the parameters (i.e. pH, ignitability) where it is not possible to prepare a spiked sample, a Sample Duplicate may be included in the QC batch. However, a Sample Duplicate is less likely to provide usable precision statistics depending on the likelihood of finding concentrations below the standard reporting limit. When the Sample Duplicate result fails to meet acceptance criteria, the data is evaluated.

For certain methods (600 series methods/CWA), a Matrix Spike is required in place of a Matrix Spike/Matrix Spike Duplicate (MS/MSD) or Matrix Spike/Sample Duplicate (MS/DU).

The acceptance criteria do not apply to samples that are diluted.

SURROGATE COMPOUNDS

In addition to these batch-related QC indicators, each organic environmental and QC sample is spiked with surrogate compounds. Surrogates are organic chemicals that behave similarly to the analytes of interest and that are rarely present in the environment. Surrogate recoveries are used to monitor the individual performance of a sample in the analytical system.

If surrogate recoveries are biased high in the LCS, LCSD, or the Method Blank, and the associated sample(s) are ND, the batch is acceptable. Otherwise, if the LCS, LCSD, or Method Blank surrogate(s) fail to meet recovery criteria, the entire sample batch is reprepared and reanalyzed. If the surrogate recoveries are outside criteria for environmental samples, the samples will be reprepared and reanalyzed unless there is objective evidence of matrix interference or if the sample dilution is greater than the threshold outlined in the associated method SOP.

The acceptance criteria do not apply to samples that are diluted. All other surrogate recoveries will be reported.

For the GC/MS BNA methods, the surrogate criterion is that two of the three surrogates for each fraction must meet acceptance criteria. The third surrogate must have a recovery of ten percent or greater.

For the Pesticide and PCB methods, the surrogate criterion is that one of two surrogate compounds must meet acceptance criteria. The second surrogate must have a recovery of 10% or greater.



TestAmerica Certifications and Approvals:

The laboratory is certified for the analytes listed on the documents below. These are available upon request.
California (#01144CA), Connecticut (#PH-0590), Florida (#E87225),
Illinois (#200004), Kansas (#E10336), Minnesota (#39-999-348), New Jersey (#OH001), New York (#10975), Nevada
(#OH-000482008A), OhioVAP (#CL0024), Pennsylvania (#008), West Virginia (#210), Wisconsin (#999518190), NAVY,
ARMY, USDA Soil Permit

EXECUTIVE SUMMARY - Detection Highlights

A0K230408

PARAMETER	RESULT	REPORTING LIMIT	UNITS	ANALYTICAL METHOD
MW-6 11/19/10 12:44 001				
Acenaphthylene	120	40	ug/L	SW846 8270C
2-Methylnaphthalene	370	40	ug/L	SW846 8270C
Naphthalene	6000	40	ug/L	SW846 8270C
Phenanthrene	55	40	ug/L	SW846 8270C
Cyanide, Total	0.038	0.010	mg/L	SW846 9012A
GP-74, 12-16' 11/18/10 15:00 002				
Acenaphthene	1100	690	ug/kg	SW846 8270C
Acenaphthylene	3100	690	ug/kg	SW846 8270C
Anthracene	3300	690	ug/kg	SW846 8270C
Benzo(a)anthracene	2400	690	ug/kg	SW846 8270C
Benzo(a)pyrene	2300	690	ug/kg	SW846 8270C
Benzo(b)fluoranthene	1500	690	ug/kg	SW846 8270C
Benzo(ghi)perylene	1300	690	ug/kg	SW846 8270C
1,1'-Biphenyl	4200 J	5200	ug/kg	SW846 8270C
Chrysene	2200	690	ug/kg	SW846 8270C
Fluoranthene	5600	690	ug/kg	SW846 8270C
Fluorene	4100	690	ug/kg	SW846 8270C
Indeno(1,2,3-cd)pyrene	880	690	ug/kg	SW846 8270C
2-Methylnaphthalene	17000	690	ug/kg	SW846 8270C
Naphthalene	130000 B	690	ug/kg	SW846 8270C
Phenanthrene	15000	690	ug/kg	SW846 8270C
Pyrene	8100	690	ug/kg	SW846 8270C
Acetone	16000 J	25000	ug/kg	SW846 8260B
Benzene	7200	6400	ug/kg	SW846 8260B
2-Butanone	11000 J	25000	ug/kg	SW846 8260B
cis-1,2-Dichloroethene	5600 J	6400	ug/kg	SW846 8260B
Ethylbenzene	9400	6400	ug/kg	SW846 8260B
4-Methyl-2-pentanone	1500 J	25000	ug/kg	SW846 8260B
Naphthalene	100000 B	6400	ug/kg	SW846 8260B
Toluene	16000	6400	ug/kg	SW846 8260B
1,2,4-Trimethylbenzene	1900 J	6400	ug/kg	SW846 8260B
1,3,5-Trimethylbenzene	800 J	6400	ug/kg	SW846 8260B
Xylenes (total)	15000	13000	ug/kg	SW846 8260B
Percent Solids	77.2	10.0	%	MCAWW 160.3 MOD
GP-57, 4-8' 11/17/10 15:10 003				
Aroclor 1242	250	41	ug/kg	SW846 8082
Aroclor 1254	410	41	ug/kg	SW846 8082
Acenaphthene	950	540	ug/kg	SW846 8270C
Acenaphthylene	8800	540	ug/kg	SW846 8270C

(Continued on next page)

EXECUTIVE SUMMARY - Detection Highlights

A0K230408

PARAMETER	RESULT	REPORTING LIMIT	UNITS	ANALYTICAL METHOD
GP-57, 4-8' 11/17/10 15:10 003				
Anthracene	8500	540	ug/kg	SW846 8270C
Benzo(a)anthracene	32000	540	ug/kg	SW846 8270C
Benzo(a)pyrene	79000	540	ug/kg	SW846 8270C
Benzo(b)fluoranthene	67000	540	ug/kg	SW846 8270C
Benzo(ghi)perylene	100000	540	ug/kg	SW846 8270C
Benzo(k)fluoranthene	25000	540	ug/kg	SW846 8270C
1,1'-Biphenyl	2400 J	4000	ug/kg	SW846 8270C
bis(2-Ethylhexyl) phthalate	4000	4000	ug/kg	SW846 8270C
Chrysene	42000	540	ug/kg	SW846 8270C
Dibenz(a,h)anthracene	13000	540	ug/kg	SW846 8270C
Fluoranthene	38000	540	ug/kg	SW846 8270C
Fluorene	4600	540	ug/kg	SW846 8270C
Indeno(1,2,3-cd)pyrene	60000	540	ug/kg	SW846 8270C
Isophorone	1100 J	4000	ug/kg	SW846 8270C
2-Methylnaphthalene	6700	540	ug/kg	SW846 8270C
Naphthalene	3700 B	540	ug/kg	SW846 8270C
Phenanthrene	35000	540	ug/kg	SW846 8270C
Pyrene	86000	540	ug/kg	SW846 8270C
Benzene	17000 J	150000	ug/kg	SW846 8260B
cis-1,2-Dichloroethene	32000 J	150000	ug/kg	SW846 8260B
Ethylbenzene	300000	150000	ug/kg	SW846 8260B
Isopropylbenzene	9600 J	150000	ug/kg	SW846 8260B
Methylcyclohexane	25000 J	310000	ug/kg	SW846 8260B
Naphthalene	49000 J,B	150000	ug/kg	SW846 8260B
Tetrachloroethene	13000 J	150000	ug/kg	SW846 8260B
Toluene	1600000	150000	ug/kg	SW846 8260B
1,1,1-Trichloroethane	160000	150000	ug/kg	SW846 8260B
Trichloroethene	20000 J	150000	ug/kg	SW846 8260B
1,2,4-Trimethylbenzene	25000 J	150000	ug/kg	SW846 8260B
1,3,5-Trimethylbenzene	8400 J	150000	ug/kg	SW846 8260B
Xylenes (total)	1300000	310000	ug/kg	SW846 8260B
Percent Solids	80.8	10.0	%	MCAWW 160.3 MOD
GP-80, 12-15' 11/19/10 11:03 004				
Aroclor 1254	150	40	ug/kg	SW846 8082
Benzo(a)pyrene	220	160	ug/kg	SW846 8270C
Benzo(b)fluoranthene	520	160	ug/kg	SW846 8270C
Benzo(ghi)perylene	630	160	ug/kg	SW846 8270C
bis(2-Ethylhexyl) phthalate	3700 B	1200	ug/kg	SW846 8270C
Butyl benzyl phthalate	920 J	1200	ug/kg	SW846 8270C

(Continued on next page)

EXECUTIVE SUMMARY - Detection Highlights

A0K230408

PARAMETER	RESULT	REPORTING LIMIT	UNITS	ANALYTICAL METHOD
GP-80, 12-15' 11/19/10 11:03 004				
Chrysene	320	160	ug/kg	SW846 8270C
Fluoranthene	290	160	ug/kg	SW846 8270C
Indeno(1,2,3-cd)pyrene	330	160	ug/kg	SW846 8270C
2-Methylnaphthalene	3100	160	ug/kg	SW846 8270C
Naphthalene	2600	160	ug/kg	SW846 8270C
Phenanthrene	270	160	ug/kg	SW846 8270C
Pyrene	470	160	ug/kg	SW846 8270C
Benzene	480 J	1500	ug/kg	SW846 8260B
2-Butanone	650 J	6000	ug/kg	SW846 8260B
1,2-Dichlorobenzene	3700	1500	ug/kg	SW846 8260B
1,3-Dichlorobenzene	51 J	1500	ug/kg	SW846 8260B
1,4-Dichlorobenzene	350 J,B	1500	ug/kg	SW846 8260B
cis-1,2-Dichloroethene	670 J	1500	ug/kg	SW846 8260B
Ethylbenzene	19000	1500	ug/kg	SW846 8260B
Isopropylbenzene	2700	1500	ug/kg	SW846 8260B
Methylcyclohexane	230 J	3000	ug/kg	SW846 8260B
Naphthalene	3900 B	1500	ug/kg	SW846 8260B
Tetrachloroethene	92 J	1500	ug/kg	SW846 8260B
Toluene	5500	1500	ug/kg	SW846 8260B
1,2,4-Trichloro- benzene	120 J	1500	ug/kg	SW846 8260B
Trichloroethene	330 J	1500	ug/kg	SW846 8260B
1,2,4-Trimethylbenzene	45000	1500	ug/kg	SW846 8260B
1,3,5-Trimethylbenzene	14000	1500	ug/kg	SW846 8260B
Xylenes (total)	85000	3000	ug/kg	SW846 8260B
Percent Solids	82.7	10.0	%	MCAWW 160.3 MOD
GP-75, 8-10' 11/18/10 15:42 005				
Aroclor 1242	250	39	ug/kg	SW846 8082
Aroclor 1254	310	39	ug/kg	SW846 8082
Acenaphthene	16	16	ug/kg	SW846 8270C
Acenaphthylene	35	16	ug/kg	SW846 8270C
Anthracene	17	16	ug/kg	SW846 8270C
Benzo(a)anthracene	86	16	ug/kg	SW846 8270C
Benzo(a)pyrene	69	16	ug/kg	SW846 8270C
Benzo(b)fluoranthene	250	16	ug/kg	SW846 8270C
Benzo(ghi)perylene	500	16	ug/kg	SW846 8270C
Benzo(k)fluoranthene	95	16	ug/kg	SW846 8270C
1,1'-Biphenyl	110 J	120	ug/kg	SW846 8270C
bis(2-Ethylhexyl) phthalate	2700	120	ug/kg	SW846 8270C
Chrysene	180	16	ug/kg	SW846 8270C

(Continued on next page)

EXECUTIVE SUMMARY - Detection Highlights

A0K230408

PARAMETER	RESULT	REPORTING LIMIT	UNITS	ANALYTICAL METHOD
GP-75, 8-10' 11/18/10 15:42 005				
Dibenz(a,h)anthracene	37	16	ug/kg	SW846 8270C
2,4-Dimethylphenol	300 J	350	ug/kg	SW846 8270C
Fluoranthene	280	16	ug/kg	SW846 8270C
Fluorene	41	16	ug/kg	SW846 8270C
Indeno(1,2,3-cd)pyrene	230	16	ug/kg	SW846 8270C
2-Methylnaphthalene	240	16	ug/kg	SW846 8270C
2-Methylphenol	1100	470	ug/kg	SW846 8270C
4-Methylphenol	990 #	470	ug/kg	SW846 8270C
Naphthalene	580 B	16	ug/kg	SW846 8270C
Phenanthrene	320	16	ug/kg	SW846 8270C
Pyrene	430	16	ug/kg	SW846 8270C
1,2-Dichlorobenzene	170 J	290	ug/kg	SW846 8260B
1,4-Dichlorobenzene	11 J,B	290	ug/kg	SW846 8260B
cis-1,2-Dichloroethene	120 J	290	ug/kg	SW846 8260B
Ethylbenzene	1600	290	ug/kg	SW846 8260B
Isopropylbenzene	200 J	290	ug/kg	SW846 8260B
Methyl acetate	55 J	580	ug/kg	SW846 8260B
Methylcyclohexane	98 J	580	ug/kg	SW846 8260B
Naphthalene	1100 B	290	ug/kg	SW846 8260B
Tetrachloroethene	50 J	290	ug/kg	SW846 8260B
Toluene	1400	290	ug/kg	SW846 8260B
1,2,4-Trichloro- benzene	22 J	290	ug/kg	SW846 8260B
1,1,1-Trichloroethane	72 J	290	ug/kg	SW846 8260B
Trichloroethene	44 J	290	ug/kg	SW846 8260B
1,2,4-Trimethylbenzene	2600	290	ug/kg	SW846 8260B
1,3,5-Trimethylbenzene	750	290	ug/kg	SW846 8260B
Xylenes (total)	11000	580	ug/kg	SW846 8260B
Percent Solids	85.6	10.0	%	MCAWW 160.3 MOD
GP-56, 8-9' 11/17/10 14:39 006				
Acenaphthene	120	18	ug/kg	SW846 8270C
Acenaphthylene	160	18	ug/kg	SW846 8270C
Anthracene	360	18	ug/kg	SW846 8270C
Benzo(a)anthracene	280	18	ug/kg	SW846 8270C
Benzo(a)pyrene	300	18	ug/kg	SW846 8270C
Benzo(b)fluoranthene	260	18	ug/kg	SW846 8270C
Benzo(ghi)perylene	240	18	ug/kg	SW846 8270C
Benzo(k)fluoranthene	100	18	ug/kg	SW846 8270C
1,1'-Biphenyl	220	140	ug/kg	SW846 8270C
bis(2-Ethylhexyl) phthalate	89 J	140	ug/kg	SW846 8270C

(Continued on next page)

EXECUTIVE SUMMARY - Detection Highlights

A0K230408

PARAMETER	RESULT	REPORTING LIMIT	UNITS	ANALYTICAL METHOD
GP-56, 8-9' 11/17/10 14:39 006				
Chrysene	320	18	ug/kg	SW846 8270C
Dibenz(a,h)anthracene	34	18	ug/kg	SW846 8270C
Fluoranthene	1100	18	ug/kg	SW846 8270C
Fluorene	560	18	ug/kg	SW846 8270C
Indeno(1,2,3-cd)pyrene	150	18	ug/kg	SW846 8270C
2-Methylnaphthalene	510	18	ug/kg	SW846 8270C
Naphthalene	330 B	18	ug/kg	SW846 8270C
Phenanthrene	3100	18	ug/kg	SW846 8270C
Pyrene	1700	18	ug/kg	SW846 8270C
1,2-Dichlorobenzene	750 J	2700	ug/kg	SW846 8260B
cis-1,2-Dichloroethene	160 J	2700	ug/kg	SW846 8260B
Ethylbenzene	12000	2700	ug/kg	SW846 8260B
Isopropylbenzene	250 J	2700	ug/kg	SW846 8260B
Methylcyclohexane	220 J	5400	ug/kg	SW846 8260B
Naphthalene	86000 B	2700	ug/kg	SW846 8260B
Tetrachloroethene	220 J	2700	ug/kg	SW846 8260B
Toluene	32000	2700	ug/kg	SW846 8260B
1,2,4-Trimethylbenzene	4400	2700	ug/kg	SW846 8260B
1,3,5-Trimethylbenzene	1500 J	2700	ug/kg	SW846 8260B
Xylenes (total)	43000	5400	ug/kg	SW846 8260B
Percent Solids	91.8	10.0	%	MCAWW 160.3 MOD
GP-54, 4-8' 11/17/10 13:38 007				
Aroclor 1254	45	37	ug/kg	SW846 8082
Acenaphthylene	2400	74	ug/kg	SW846 8270C
Anthracene	510	74	ug/kg	SW846 8270C
Benzo(a)anthracene	2100	74	ug/kg	SW846 8270C
Benzo(a)pyrene	3600	74	ug/kg	SW846 8270C
Benzo(b)fluoranthene	4100	74	ug/kg	SW846 8270C
Benzo(ghi)perylene	6300	74	ug/kg	SW846 8270C
Benzo(k)fluoranthene	1500	74	ug/kg	SW846 8270C
bis(2-Ethylhexyl) phthalate	2400 B	550	ug/kg	SW846 8270C
Butyl benzyl phthalate	470 J	550	ug/kg	SW846 8270C
Chrysene	2500	74	ug/kg	SW846 8270C
Fluoranthene	2900	74	ug/kg	SW846 8270C
Fluorene	190	74	ug/kg	SW846 8270C
Indeno(1,2,3-cd)pyrene	3500	74	ug/kg	SW846 8270C
2-Methylnaphthalene	140	74	ug/kg	SW846 8270C
Naphthalene	120	74	ug/kg	SW846 8270C
Phenanthrene	580	74	ug/kg	SW846 8270C
Pyrene	6000	74	ug/kg	SW846 8270C

(Continued on next page)

EXECUTIVE SUMMARY - Detection Highlights

A0K230408

PARAMETER	RESULT	REPORTING LIMIT	UNITS	ANALYTICAL METHOD
GP-54, 4-8' 11/17/10 13:38 007				
Acetone	820 J	3600	ug/kg	SW846 8260B
2-Butanone	520 J	3600	ug/kg	SW846 8260B
Carbon disulfide	150 J	910	ug/kg	SW846 8260B
Cyclohexane	160 J	1800	ug/kg	SW846 8260B
1,2-Dichlorobenzene	460 J	910	ug/kg	SW846 8260B
1,3-Dichlorobenzene	63 J	910	ug/kg	SW846 8260B
1,4-Dichlorobenzene	170 J,B	910	ug/kg	SW846 8260B
1,1-Dichloroethene	400 J	910	ug/kg	SW846 8260B
cis-1,2-Dichloroethene	1100	910	ug/kg	SW846 8260B
Ethylbenzene	320 J	910	ug/kg	SW846 8260B
Isopropylbenzene	53 J	910	ug/kg	SW846 8260B
Methyl acetate	210 J	1800	ug/kg	SW846 8260B
Methylcyclohexane	280 J	1800	ug/kg	SW846 8260B
Naphthalene	230 J,B	910	ug/kg	SW846 8260B
Tetrachloroethene	11000	910	ug/kg	SW846 8260B
Toluene	430 J	910	ug/kg	SW846 8260B
1,2,4-Trichloro- benzene	140 J	910	ug/kg	SW846 8260B
1,1,1-Trichloroethane	17000	910	ug/kg	SW846 8260B
Trichloroethene	17000	910	ug/kg	SW846 8260B
1,2,4-Trimethylbenzene	1100	910	ug/kg	SW846 8260B
1,3,5-Trimethylbenzene	1200	910	ug/kg	SW846 8260B
Xylenes (total)	6600	1800	ug/kg	SW846 8260B
Percent Solids	90.2	10.0	%	MCAWW 160.3 MOD
GP-47, 4-6' 11/17/10 09:38 008				
Acenaphthene	9300	710	ug/kg	SW846 8270C
Acenaphthylene	36000	710	ug/kg	SW846 8270C
Anthracene	20000	710	ug/kg	SW846 8270C
Benzo(a)anthracene	12000	710	ug/kg	SW846 8270C
Benzo(a)pyrene	15000	710	ug/kg	SW846 8270C
Benzo(b)fluoranthene	12000	710	ug/kg	SW846 8270C
Benzo(ghi)perylene	14000	710	ug/kg	SW846 8270C
Benzo(k)fluoranthene	3500	710	ug/kg	SW846 8270C
1,1'-Biphenyl	18000	5300	ug/kg	SW846 8270C
Butyl benzyl phthalate	1800 J	5300	ug/kg	SW846 8270C
Chrysene	13000	710	ug/kg	SW846 8270C
Dibenz(a,h)anthracene	1300	710	ug/kg	SW846 8270C
Fluoranthene	48000	710	ug/kg	SW846 8270C
Fluorene	35000	710	ug/kg	SW846 8270C
Indeno(1,2,3-cd)pyrene	8200	710	ug/kg	SW846 8270C
2-Methylnaphthalene	51000	710	ug/kg	SW846 8270C

(Continued on next page)

EXECUTIVE SUMMARY - Detection Highlights

A0K230408

PARAMETER	RESULT	REPORTING LIMIT	UNITS	ANALYTICAL METHOD
GP-47, 4-6' 11/17/10 09:38 008				
Naphthalene	9100 B	710	ug/kg	SW846 8270C
Phenanthrene	120000	710	ug/kg	SW846 8270C
Pyrene	69000	710	ug/kg	SW846 8270C
1,2-Dichlorobenzene	1800	260	ug/kg	SW846 8260B
1,3-Dichlorobenzene	41 J	260	ug/kg	SW846 8260B
1,4-Dichlorobenzene	360 B	260	ug/kg	SW846 8260B
cis-1,2-Dichloroethene	30 J	260	ug/kg	SW846 8260B
Ethylbenzene	590	260	ug/kg	SW846 8260B
Isopropylbenzene	66 J	260	ug/kg	SW846 8260B
Methylcyclohexane	25 J	530	ug/kg	SW846 8260B
Naphthalene	2500 B	260	ug/kg	SW846 8260B
Tetrachloroethene	130 J	260	ug/kg	SW846 8260B
Toluene	440	260	ug/kg	SW846 8260B
1,2,4-Trichloro- benzene	15 J	260	ug/kg	SW846 8260B
1,1,1-Trichloroethane	140 J	260	ug/kg	SW846 8260B
Trichloroethene	1000	260	ug/kg	SW846 8260B
1,2,4-Trimethylbenzene	720	260	ug/kg	SW846 8260B
1,3,5-Trimethylbenzene	490	260	ug/kg	SW846 8260B
Xylenes (total)	6300	530	ug/kg	SW846 8260B
Percent Solids	93.9	10.0	%	MCAWW 160.3 MOD
MW-6 LNAPL 11/16/10 16:10 009				
Naphthalene	28000000	1000000	ug/kg	SW846 8260B
	Qualifiers: B			
Styrene	590000	520000	ug/kg	SW846 8260B
Toluene	440000 J	520000	ug/kg	SW846 8260B
1,2,4-Trimethylbenzene	1000000	1000000	ug/kg	SW846 8260B
1,3,5-Trimethylbenzene	820000 J	1000000	ug/kg	SW846 8260B
Xylenes (total)	430000 J	520000	ug/kg	SW846 8260B
MW-6 DNAPL 11/16/10 16:10 010				
Acenaphthene	52000	25000	ug/kg	SW846 8270C
Acenaphthylene	380000	25000	ug/kg	SW846 8270C
Anthracene	310000	25000	ug/kg	SW846 8270C
Benzo(a)pyrene	260000	25000	ug/kg	SW846 8270C
Benzo(b)fluoranthene	200000	25000	ug/kg	SW846 8270C
Benzo(ghi)perylene	150000	25000	ug/kg	SW846 8270C
Benzo(k)fluoranthene	110000	25000	ug/kg	SW846 8270C
1,1'-Biphenyl	130000 J	180000	ug/kg	SW846 8270C
Fluoranthene	600000	25000	ug/kg	SW846 8270C

(Continued on next page)

EXECUTIVE SUMMARY - Detection Highlights

A0K230408

PARAMETER	RESULT	REPORTING LIMIT	UNITS	ANALYTICAL METHOD
MW-6 DNAPL 11/16/10 16:10 010				
Fluorene	280000	25000	ug/kg	SW846 8270C
Indeno(1,2,3-cd)pyrene	91000	25000	ug/kg	SW846 8270C
2-Methylnaphthalene	790000	25000	ug/kg	SW846 8270C
Naphthalene	3400000	25000	ug/kg	SW846 8270C
Phenanthrene	1200000	25000	ug/kg	SW846 8270C
Pyrene	850000	25000	ug/kg	SW846 8270C
GP-84, 15-16' 11/19/10 14:20 011				
Acenaphthene	7600	1000	ug/kg	SW846 8270C
Acenaphthylene	5200	1000	ug/kg	SW846 8270C
Anthracene	20000	1000	ug/kg	SW846 8270C
Benzo(a)anthracene	13000	1000	ug/kg	SW846 8270C
Benzo(a)pyrene	12000	1000	ug/kg	SW846 8270C
Benzo(b)fluoranthene	8100	1000	ug/kg	SW846 8270C
Benzo(ghi)perylene	6800	1000	ug/kg	SW846 8270C
Benzo(k)fluoranthene	4500	1000	ug/kg	SW846 8270C
1,1'-Biphenyl	10000	7900	ug/kg	SW846 8270C
Chrysene	12000	1000	ug/kg	SW846 8270C
Fluoranthene	29000	1000	ug/kg	SW846 8270C
Fluorene	15000	1000	ug/kg	SW846 8270C
Indeno(1,2,3-cd)pyrene	4100	1000	ug/kg	SW846 8270C
2-Methylnaphthalene	57000	1000	ug/kg	SW846 8270C
Naphthalene	250000	1000	ug/kg	SW846 8270C
Phenanthrene	72000	1000	ug/kg	SW846 8270C
Pyrene	47000	1000	ug/kg	SW846 8270C
Benzene	19000	15000	ug/kg	SW846 8260B
2-Butanone	7900 J	62000	ug/kg	SW846 8260B
1,1-Dichloroethane	1600 J	15000	ug/kg	SW846 8260B
cis-1,2-Dichloroethene	11000 J	15000	ug/kg	SW846 8260B
Ethylbenzene	29000	15000	ug/kg	SW846 8260B
Naphthalene	490000 B	15000	ug/kg	SW846 8260B
Styrene	3600 J	15000	ug/kg	SW846 8260B
Toluene	120000	15000	ug/kg	SW846 8260B
1,1,1-Trichloroethane	9900 J	15000	ug/kg	SW846 8260B
Trichloroethene	740 J	15000	ug/kg	SW846 8260B
1,2,4-Trimethylbenzene	14000 J	15000	ug/kg	SW846 8260B
1,3,5-Trimethylbenzene	5200 J	15000	ug/kg	SW846 8260B
Xylenes (total)	63000	31000	ug/kg	SW846 8260B
Percent Solids	79.5	10.0	%	MCAWW 160.3 MOD

ANALYTICAL METHODS SUMMARY

A0K230408

<u>PARAMETER</u>	<u>ANALYTICAL METHOD</u>
Cyanide, Total	SW846 9012A
PCBs by SW-846 8082	SW846 8082
Semivolatile Organic Compounds by GC/MS	SW846 8270C
Total Residue as Percent Solids	MCAWW 160.3 MOD
Volatile Organics by GC/MS	SW846 8260B

References:

- MCAWW "Methods for Chemical Analysis of Water and Wastes",
EPA-600/4-79-020, March 1983 and subsequent revisions.
- SW846 "Test Methods for Evaluating Solid Waste, Physical/Chemical
Methods", Third Edition, November 1986 and its updates.

SAMPLE SUMMARY

A0K230408

WO #	SAMPLE#	CLIENT	SAMPLE ID	SAMPLED DATE	SAMP TIME
MAFNX	001	MW-6		11/19/10	12:44
MAFPA	002	GP-74,	12-16'	11/18/10	15:00
MAFPF	003	GP-57,	4-8'	11/17/10	15:10
MAFPG	004	GP-80,	12-15'	11/19/10	11:03
MAFPL	005	GP-75,	8-10'	11/18/10	15:42
MAFPN	006	GP-56,	8-9'	11/17/10	14:39
MAFPP	007	GP-54,	4-8'	11/17/10	13:38
MAFPQ	008	GP-47,	4-6'	11/17/10	09:38
MAFPR	009	MW-6	LNAPL	11/16/10	16:10
MAFPV	010	MW-6	DNAPL	11/16/10	16:10
MAFPW	011	GP-84,	15-16'	11/19/10	14:20

NOTE(S) :

- The analytical results of the samples listed above are presented on the following pages.
- All calculations are performed before rounding to avoid round-off errors in calculated results.
- Results noted as "ND" were not detected at or above the stated limit.
- This report must not be reproduced, except in full, without the written approval of the laboratory.
- Results for the following parameters are never reported on a dry weight basis: color, corrosivity, density, flashpoint, ignitability, layers, odor, paint filter test, pH, porosity pressure, reactivity, redox potential, specific gravity, spot tests, solids, solubility, temperature, viscosity, and weight.

Brown and Caldwell

Client Sample ID: MW-6

GC/MS Semivolatiles

Lot-Sample #...: A0K230408-001 Work Order #...: MAFNX1AA Matrix.....: WG
 Date Sampled...: 11/19/10 12:44 Date Received...: 11/20/10
 Prep Date.....: 11/26/10 Analysis Date...: 12/04/10
 Prep Batch #...: 0329024
 Dilution Factor: 200 Method.....: SW846 8270C

PARAMETER	RESULT	REPORTING		
		LIMIT	UNITS	MDL
Acenaphthene	ND	40	ug/L	20
Acenaphthylene	120	40	ug/L	20
Acetophenone	ND	200	ug/L	68
Anthracene	ND	40	ug/L	20
Atrazine	ND	200	ug/L	68
Benzo(a)anthracene	ND	40	ug/L	20
Benzo(a)pyrene	ND	40	ug/L	20
Benzo(b)fluoranthene	ND	40	ug/L	20
Benzo(ghi)perylene	ND	40	ug/L	20
Benzo(k)fluoranthene	ND	40	ug/L	20
Benzaldehyde	ND	200	ug/L	78
1,1'-Biphenyl	ND	200	ug/L	160
bis(2-Chloroethoxy) methane	ND	200	ug/L	64
bis(2-Chloroethyl)- ether	ND	200	ug/L	20
bis(2-Ethylhexyl) phthalate	ND	400	ug/L	160
4-Bromophenyl phenyl ether	ND	400	ug/L	160
Butyl benzyl phthalate	ND	200	ug/L	160
Caprolactam	ND	1000	ug/L	160
Carbazole	ND	200	ug/L	56
4-Chloroaniline	ND	400	ug/L	160
4-Chloro-3-methylphenol	ND	400	ug/L	160
2-Chloronaphthalene	ND	200	ug/L	20
2-Chlorophenol	ND	200	ug/L	58
4-Chlorophenyl phenyl ether	ND	400	ug/L	60
Chrysene	ND	40	ug/L	20
Dibenz(a,h)anthracene	ND	40	ug/L	20
Dibenzofuran	ND	200	ug/L	20
3,3'-Dichlorobenzidine	ND	1000	ug/L	74
2,4-Dichlorophenol	ND	400	ug/L	160
Diethyl phthalate	ND	200	ug/L	120
2,4-Dimethylphenol	ND	400	ug/L	160
Dimethyl phthalate	ND	200	ug/L	58
Di-n-butyl phthalate	ND	200	ug/L	130
4,6-Dinitro- 2-methylphenol	ND	1000	ug/L	480

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Brown and Caldwell

Client Sample ID: MW-6

GC/MS Semivolatiles

Lot-Sample #...: A0K230408-001

Work Order #...: MAFNX1AA

Matrix.....: WG

PARAMETER	RESULT	REPORTING		
		LIMIT	UNITS	MDL
2,4-Dinitrophenol	ND	1000	ug/L	480
2,4-Dinitrotoluene	ND	1000	ug/L	54
2,6-Dinitrotoluene	ND	1000	ug/L	160
Di-n-octyl phthalate	ND	200	ug/L	160
Fluoranthene	ND	40	ug/L	20
Fluorene	ND	40	ug/L	20
Hexachlorobenzene	ND	40	ug/L	20
Hexachlorobutadiene	ND	200	ug/L	54
Hexachlorocyclopenta- diene	ND	2000	ug/L	160
Hexachloroethane	ND	200	ug/L	160
Indeno(1,2,3-cd)pyrene	ND	40	ug/L	20
Isophorone	ND	200	ug/L	54
2-Methylnaphthalene	370	40	ug/L	20
2-Methylphenol	ND	200	ug/L	160
4-Methylphenol	ND	200	ug/L	160
Naphthalene	6000	40	ug/L	20
2-Nitroaniline	ND	400	ug/L	160
3-Nitroaniline	ND	400	ug/L	56
4-Nitroaniline	ND	400	ug/L	160
Nitrobenzene	ND	200	ug/L	8.0
2-Nitrophenol	ND	400	ug/L	56
4-Nitrophenol	ND	1000	ug/L	480
N-Nitrosodi-n-propyl- amine	ND	200	ug/L	160
N-Nitrosodiphenylamine	ND	200	ug/L	62
2,2'-oxybis (1-Chloropropane)	ND	200	ug/L	80
Pentachlorophenol	ND	1000	ug/L	480
Phenanthrene	55	40	ug/L	20
Phenol	ND	200	ug/L	120
Pyrene	ND	40	ug/L	20
2,4,5-Trichloro- phenol	ND	1000	ug/L	60
2,4,6-Trichloro- phenol	ND	1000	ug/L	160
SURROGATE	PERCENT		RECOVERY	
	RECOVERY		LIMITS	
Nitrobenzene-d5	0.0 DIL, *		(27 - 111)	
2-Fluorobiphenyl	0.0 DIL, *		(28 - 110)	
Terphenyl-d14	0.0 DIL, *		(37 - 119)	
Phenol-d5	0.0 DIL, *		(10 - 110)	
2-Fluorophenol	0.0 DIL, *		(10 - 110)	
2,4,6-Tribromophenol	0.0 DIL, *		(22 - 120)	

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Brown and Caldwell

Client Sample ID: MW-6

GC/MS Semivolatiles

Lot-Sample #...: A0K230408-001 Work Order #...: MAFNX1AA Matrix.....: WG

NOTE(S):

DIL The concentration is estimated or not reported due to dilution or the presence of interfering analytes.

* Surrogate recovery is outside stated control limits.

Brown and Caldwell

MW-6

GC/MS Semivolatiles

Lot-Sample #: A0K230408-001

Work Order #: MAFNX1AA

Matrix: WG

MASS SPECTROMETER/DATA SYSTEM (MSDS) TENTATIVELY IDENTIFIED COMPOUNDS

PARAMETER	CAS #	ESTIMATED	RETENTION		UNITS
		RESULT	TIME		
Unknown Aromatic		940 J	M 2.9293		ug/L
Unknown Aromatic		530 J	M 3.6078		ug/L
Unknown		400 J	M 3.8963		ug/L
Indene	95-13-6	1200 NJ	M 3.939		ug/L
Unknown		400 J	M 4.3397		ug/L
1H-Indene, 1-methyl-	767-59-9	180 NJ	M 4.5106		ug/L
Unknown Aromatic		180 J	M 4.5373		ug/L
Naphthalene, 1-methyl-	90-12-0	260 NJ	M 5.3066		ug/L

NOTE(S):

M: Result was measured against nearest internal standard assuming a response factor of 1.

Brown and Caldwell

Client Sample ID: MW-6

GC Semivolatiles

Lot-Sample #...: A0K230408-001 Work Order #...: MAFNX1AD Matrix.....: WG
Date Sampled...: 11/19/10 12:44 Date Received...: 11/20/10
Prep Date.....: 12/02/10 Analysis Date...: 12/02/10
Prep Batch #...: 0336047
Dilution Factor: 1 Method.....: SW846 8082

<u>PARAMETER</u>	<u>RESULT</u>	<u>REPORTING</u>		
		<u>LIMIT</u>	<u>UNITS</u>	<u>MDL</u>
Aroclor 1016	ND	1.0	ug/L	0.17
Aroclor 1221	ND	1.0	ug/L	0.13
Aroclor 1232	ND	1.0	ug/L	0.16
Aroclor 1242	ND	1.0	ug/L	0.22
Aroclor 1248	ND	1.0	ug/L	0.10
Aroclor 1254	ND	1.0	ug/L	0.16
Aroclor 1260	ND	1.0	ug/L	0.17

<u>SURROGATE</u>	<u>PERCENT</u>	<u>RECOVERY</u>
	<u>RECOVERY</u>	<u>LIMITS</u>
Tetrachloro-m-xylene	133 *	(27 - 130)
Decachlorobiphenyl	45	(10 - 127)

NOTE(S):

* Surrogate recovery is outside stated control limits.

Brown and Caldwell

Client Sample ID: MW-6

General Chemistry

Lot-Sample #...: A0K230408-001 Work Order #...: MAFNX Matrix.....: WG

Date Sampled...: 11/19/10 12:44 Date Received..: 11/20/10

<u>PARAMETER</u>	<u>RESULT</u>	<u>RL</u>	<u>UNITS</u>	<u>METHOD</u>	<u>PREPARATION- ANALYSIS DATE</u>	<u>PREP BATCH #</u>
Cyanide, Total	0.038	0.010	mg/L	SW846 9012A	12/01/10	0335134
		Dilution Factor: 1		MDL.....: 0.0050		

Brown and Caldwell

Client Sample ID: GP-74, 12-16'

GC/MS Volatiles

Lot-Sample #...: A0K230408-002 Work Order #...: MAFPA1AF Matrix.....: SO
 Date Sampled...: 11/18/10 15:00 Date Received...: 11/20/10
 Prep Date.....: 11/30/10 Analysis Date...: 12/02/10
 Prep Batch #...: 0336449
 Dilution Factor: 19.65
 % Moisture.....: 23 Method.....: SW846 8260B

PARAMETER	RESULT	REPORTING		
		LIMIT	UNITS	MDL
Acetone	16000 J	25000	ug/kg	4300
Benzene	7200	6400	ug/kg	310
Bromodichloromethane	ND	6400	ug/kg	250
Bromoform	ND	6400	ug/kg	480
Bromomethane	ND	6400	ug/kg	740
2-Butanone	11000 J	25000	ug/kg	1100
Carbon disulfide	ND	6400	ug/kg	310
Carbon tetrachloride	ND	6400	ug/kg	160
Chlorobenzene	ND	6400	ug/kg	160
Dibromochloromethane	ND	6400	ug/kg	310
1,2-Dibromo-3-chloro- propane	ND	13000	ug/kg	1300
Chloroethane	ND	6400	ug/kg	1600
Chloroform	ND	6400	ug/kg	220
Chloromethane	ND	6400	ug/kg	360
Cyclohexane	ND	13000	ug/kg	1000
1,2-Dibromoethane	ND	6400	ug/kg	250
1,2-Dichlorobenzene	ND	6400	ug/kg	220
1,3-Dichlorobenzene	ND	6400	ug/kg	120
1,4-Dichlorobenzene	ND	6400	ug/kg	200
Dichlorodifluoromethane	ND	6400	ug/kg	410
1,1-Dichloroethane	ND	6400	ug/kg	430
1,2-Dichloroethane	ND	6400	ug/kg	250
1,1-Dichloroethene	ND	6400	ug/kg	460
cis-1,2-Dichloroethene	5600 J	6400	ug/kg	180
trans-1,2-Dichloroethene	ND	6400	ug/kg	230
1,2-Dichloropropane	ND	6400	ug/kg	210
cis-1,3-Dichloropropene	ND	6400	ug/kg	200
trans-1,3-Dichloropropene	ND	6400	ug/kg	510
Ethylbenzene	9400	6400	ug/kg	140
Trichlorofluoromethane	ND	6400	ug/kg	410
2-Hexanone	ND	25000	ug/kg	510
Isopropylbenzene	ND	6400	ug/kg	170
Methyl acetate	ND	13000	ug/kg	640
Methylcyclohexane	ND	13000	ug/kg	310
Methylene chloride	ND	6400	ug/kg	2000
4-Methyl-2-pentanone	1500 J	25000	ug/kg	1200
Naphthalene	100000 B	6400	ug/kg	170

(Continued on next page)

Brown and Caldwell

Client Sample ID: GP-74, 12-16'

GC/MS Volatiles

Lot-Sample #...: A0K230408-002 Work Order #...: MAFPA1AF Matrix.....: SO

PARAMETER	RESULT	REPORTING		
		LIMIT	UNITS	MDL
Styrene	ND	6400	ug/kg	140
1,1,2,2-Tetrachloroethane	ND	6400	ug/kg	230
Tetrachloroethene	ND	6400	ug/kg	310
Toluene	16000	6400	ug/kg	430
1,2,4-Trichloro-benzene	ND	6400	ug/kg	190
1,1,1-Trichloroethane	ND	6400	ug/kg	530
1,1,2-Trichloroethane	ND	6400	ug/kg	310
Trichloroethene	ND	6400	ug/kg	250
1,1,2-Trichloro-1,2,2-trifluoroethane	ND	6400	ug/kg	990
1,2,4-Trimethylbenzene	1900 J	6400	ug/kg	130
1,3,5-Trimethylbenzene	800 J	6400	ug/kg	150
Vinyl chloride	ND	6400	ug/kg	460
Xylenes (total)	15000	13000	ug/kg	210
Methyl tert-butyl ether	ND	25000	ug/kg	180

SURROGATE	PERCENT		RECOVERY	
	RECOVERY		LIMITS	
Dibromofluoromethane	74	DIL	(30 - 122)	
1,2-Dichloroethane-d4	72	DIL	(39 - 128)	
Toluene-d8	65	DIL	(33 - 134)	
4-Bromofluorobenzene	77	DIL	(26 - 141)	

NOTE(S):

DIL The concentration is estimated or not reported due to dilution or the presence of interfering analytes.

Results and reporting limits have been adjusted for dry weight.

J Estimated result. Result is less than RL.

B Method blank contamination. The associated method blank contains the target analyte at a reportable level.

Brown and Caldwell

GP-74, 12-16'

GC/MS Volatiles

Lot-Sample #: A0K230408-002

Work Order #: MAFPA1AF

Matrix: SO

MASS SPECTROMETER/DATA SYSTEM (MSDS) TENTATIVELY IDENTIFIED COMPOUNDS

<u>PARAMETER</u>	<u>CAS #</u>	<u>ESTIMATED RESULT</u>	<u>RETENTION TIME</u>	<u>UNITS</u>
Indene	95-13-6	13000 NJ M	10.518	ug/kg
2-Methylnaphthalene		14000 Q	13.642	ug/kg

NOTE(S):

Q: Result was quantitated against the response factor of a calibration standard.

M: Result was measured against nearest internal standard assuming a response factor of 1.

Brown and Caldwell

Client Sample ID: GP-74, 12-16'

GC/MS Semivolatiles

Lot-Sample #...: A0K230408-002 Work Order #...: MAFPA1AC Matrix.....: SO
 Date Sampled...: 11/18/10 15:00 Date Received...: 11/20/10
 Prep Date.....: 11/29/10 Analysis Date...: 12/04/10
 Prep Batch #...: 0333049
 Dilution Factor: 80
 % Moisture.....: 23 Method.....: SW846 8270C

PARAMETER	RESULT	REPORTING		
		LIMIT	UNITS	MDL
Acenaphthene	1100	690	ug/kg	340
Acenaphthylene	3100	690	ug/kg	340
Acetophenone	ND	10000	ug/kg	950
Anthracene	3300	690	ug/kg	340
Atrazine	ND	21000	ug/kg	940
Benzo(a)anthracene	2400	690	ug/kg	340
Benzo(a)pyrene	2300	690	ug/kg	340
Benzo(b)fluoranthene	1500	690	ug/kg	340
Benzo(ghi)perylene	1300	690	ug/kg	340
Benzo(k)fluoranthene	ND	690	ug/kg	340
Benzaldehyde	ND	10000	ug/kg	1200
1,1'-Biphenyl	4200 J	5200	ug/kg	2800
bis(2-Chloroethoxy) methane	ND	10000	ug/kg	2300
bis(2-Chloroethyl)- ether	ND	10000	ug/kg	210
bis(2-Ethylhexyl) phthalate	ND	5200	ug/kg	2000
4-Bromophenyl phenyl ether	ND	5200	ug/kg	1300
Butyl benzyl phthalate	ND	5200	ug/kg	1000
Caprolactam	ND	34000	ug/kg	3800
Carbazole	ND	5200	ug/kg	2800
4-Chloroaniline	ND	16000	ug/kg	1800
4-Chloro-3-methylphenol	ND	16000	ug/kg	2200
2-Chloronaphthalene	ND	5200	ug/kg	340
2-Chlorophenol	ND	5200	ug/kg	2800
4-Chlorophenyl phenyl ether	ND	5200	ug/kg	1300
Chrysene	2200	690	ug/kg	110
Dibenz(a,h)anthracene	ND	690	ug/kg	340
Dibenzofuran	ND	5200	ug/kg	340
3,3'-Dichlorobenzidine	ND	10000	ug/kg	1900
2,4-Dichlorophenol	ND	16000	ug/kg	2100
Diethyl phthalate	ND	5200	ug/kg	1700
2,4-Dimethylphenol	ND	16000	ug/kg	2100
Dimethyl phthalate	ND	5200	ug/kg	1800
Di-n-butyl phthalate	ND	5200	ug/kg	1600

(Continued on next page)

Brown and Caldwell

Client Sample ID: GP-74, 12-16'

GC/MS Semivolatiles

Lot-Sample #...: A0K230408-002 Work Order #...: MAFPA1AC Matrix.....: SO

PARAMETER	RESULT	REPORTING		
		LIMIT	UNITS	MDL
4,6-Dinitro- 2-methylphenol	ND	16000	ug/kg	8300
2,4-Dinitrophenol	ND	34000	ug/kg	8300
2,4-Dinitrotoluene	ND	21000	ug/kg	2800
2,6-Dinitrotoluene	ND	21000	ug/kg	2200
Di-n-octyl phthalate	ND	5200	ug/kg	2800
Fluoranthene	5600	690	ug/kg	340
Fluorene	4100	690	ug/kg	340
Hexachlorobenzene	ND	690	ug/kg	220
Hexachlorobutadiene	ND	5200	ug/kg	2800
Hexachlorocyclopenta- diene	ND	34000	ug/kg	2800
Hexachloroethane	ND	5200	ug/kg	930
Indeno(1,2,3-cd)pyrene	880	690	ug/kg	340
Isophorone	ND	5200	ug/kg	1300
2-Methylnaphthalene	17000	690	ug/kg	340
2-Methylphenol	ND	21000	ug/kg	8300
4-Methylphenol	ND	21000	ug/kg	8300
Naphthalene	130000 B	690	ug/kg	340
2-Nitroaniline	ND	21000	ug/kg	940
3-Nitroaniline	ND	21000	ug/kg	1700
4-Nitroaniline	ND	21000	ug/kg	2700
Nitrobenzene	ND	10000	ug/kg	230
2-Nitrophenol	ND	5200	ug/kg	2800
4-Nitrophenol	ND	34000	ug/kg	8300
N-Nitrosodi-n-propyl- amine	ND	5200	ug/kg	2800
N-Nitrosodiphenylamine	ND	5200	ug/kg	2200
2,2'-oxybis (1-Chloropropane)	ND	10000	ug/kg	980
Pentachlorophenol	ND	16000	ug/kg	8300
Phenanthrene	15000	690	ug/kg	340
Phenol	ND	5200	ug/kg	2800
Pyrene	8100	690	ug/kg	340
2,4,5-Trichloro- phenol	ND	16000	ug/kg	2600
2,4,6-Trichloro- phenol	ND	16000	ug/kg	8300

(Continued on next page)

Brown and Caldwell

Client Sample ID: GP-74, 12-16'

GC/MS Semivolatiles

Lot-Sample #...: A0K230408-002 Work Order #...: MAFPA1AC Matrix.....: SO

<u>SURROGATE</u>	<u>PERCENT RECOVERY</u>	<u>RECOVERY LIMITS</u>
Nitrobenzene-d5	0.0 DIL, *	(24 - 112)
2-Fluorobiphenyl	0.0 DIL, *	(34 - 110)
Terphenyl-d14	0.0 DIL, *	(41 - 119)
Phenol-d5	0.0 DIL, *	(28 - 110)
2-Fluorophenol	0.0 DIL, *	(26 - 110)
2,4,6-Tribromophenol	0.0 DIL, *	(10 - 118)

NOTE(S):

DIL The concentration is estimated or not reported due to dilution or the presence of interfering analytes.

* Surrogate recovery is outside stated control limits.

Results and reporting limits have been adjusted for dry weight.

J Estimated result. Result is less than RL.

B Method blank contamination. The associated method blank contains the target analyte at a reportable level.

Brown and Caldwell

GP-74, 12-16'

GC/MS Semivolatiles

Lot-Sample #: A0K230408-002

Work Order #: MAFPA1AC

Matrix: SO

MASS SPECTROMETER/DATA SYSTEM (MSDS) TENTATIVELY IDENTIFIED COMPOUNDS

PARAMETER	CAS #	ESTIMATED		RETENTION	
		RESULT		TIME	UNITS
Unknown Aromatic		6000 J	M	2.7555	ug/kg
Unknown Aromatic		3100 J	M	2.9264	ug/kg
Unknown Aromatic		4600 J	M	3.6102	ug/kg
2-Pyrrolidinone, 1-methyl-	872-50-4	9000 NJ	M	3.8292	ug/kg
Unknown		3000 J	M	3.8933	ug/kg
Indene	95-13-6	13000 NJ	M	3.9414	ug/kg
Unknown PAH		2800 J	M	7.5313	ug/kg
Unknown		3500 J	M	9.6735	ug/kg

NOTE(S):

M: Result was measured against nearest internal standard assuming a response factor of 1.

Brown and Caldwell

Client Sample ID: GP-74, 12-16'

GC Semivolatiles

Lot-Sample #...: A0K230408-002 Work Order #...: MAFPA1AG Matrix.....: SO
Date Sampled...: 11/18/10 15:00 Date Received..: 11/20/10
Prep Date.....: 12/02/10 Analysis Date..: 12/03/10
Prep Batch #...: 0336049
Dilution Factor: 1
% Moisture.....: 23 Method.....: SW846 8082

		REPORTING		
<u>PARAMETER</u>	<u>RESULT</u>	<u>LIMIT</u>	<u>UNITS</u>	<u>MDL</u>
Aroclor 1016	ND	43	ug/kg	27
Aroclor 1221	ND	43	ug/kg	21
Aroclor 1232	ND	43	ug/kg	18
Aroclor 1242	ND	43	ug/kg	17
Aroclor 1248	ND	43	ug/kg	22
Aroclor 1254	ND	43	ug/kg	22
Aroclor 1260	ND	43	ug/kg	22
	PERCENT	RECOVERY		
<u>SURROGATE</u>	<u>RECOVERY</u>	<u>LIMITS</u>		
Tetrachloro-m-xylene	89	(10 - 196)		
Decachlorobiphenyl	91	(10 - 199)		

NOTE(S):

Results and reporting limits have been adjusted for dry weight.

Brown and Caldwell

Client Sample ID: GP-74, 12-16'

General Chemistry

Lot-Sample #...: A0K230408-002 Work Order #...: MAFPA Matrix.....: SO
Date Sampled...: 11/18/10 15:00 Date Received..: 11/20/10
% Moisture.....: 23

<u>PARAMETER</u>	<u>RESULT</u>	<u>RL</u>	<u>UNITS</u>	<u>METHOD</u>	<u>PREPARATION- ANALYSIS DATE</u>	<u>PREP BATCH #</u>
Percent Solids	77.2	10.0	%	MCAWW 160.3 MOD	12/01-12/02/10	0335256
		Dilution Factor: 1		MDL.....: 10.0		

Brown and Caldwell

Client Sample ID: GP-57, 4-8'

GC/MS Volatiles

Lot-Sample #...: A0K230408-003 Work Order #...: MAFPF1AD Matrix.....: SO
 Date Sampled...: 11/17/10 15:10 Date Received...: 11/20/10
 Prep Date.....: 11/30/10 Analysis Date...: 12/01/10
 Prep Batch #...: 0336449
 Dilution Factor: 500
 % Moisture.....: 19 Method.....: SW846 8260B

PARAMETER	RESULT	REPORTING		
		LIMIT	UNITS	MDL
Acetone	ND	620000	ug/kg	110000
Benzene	17000 J	150000	ug/kg	7400
Bromodichloromethane	ND	150000	ug/kg	6100
Bromoform	ND	150000	ug/kg	12000
Bromomethane	ND	150000	ug/kg	18000
2-Butanone	ND	620000	ug/kg	27000
Carbon disulfide	ND	150000	ug/kg	7400
Carbon tetrachloride	ND	150000	ug/kg	4000
Chlorobenzene	ND	150000	ug/kg	4000
Dibromochloromethane	ND	150000	ug/kg	7400
1,2-Dibromo-3-chloro- propane	ND	310000	ug/kg	31000
Chloroethane	ND	150000	ug/kg	38000
Chloroform	ND	150000	ug/kg	5400
Chloromethane	ND	150000	ug/kg	8700
Cyclohexane	ND	310000	ug/kg	25000
1,2-Dibromoethane	ND	150000	ug/kg	6200
1,2-Dichlorobenzene	ND	150000	ug/kg	5300
1,3-Dichlorobenzene	ND	150000	ug/kg	3000
1,4-Dichlorobenzene	ND	150000	ug/kg	5000
Dichlorodifluoromethane	ND	150000	ug/kg	9900
1,1-Dichloroethane	ND	150000	ug/kg	11000
1,2-Dichloroethane	ND	150000	ug/kg	6200
1,1-Dichloroethene	ND	150000	ug/kg	11000
cis-1,2-Dichloroethene	32000 J	150000	ug/kg	4300
trans-1,2-Dichloroethene	ND	150000	ug/kg	5700
1,2-Dichloropropane	ND	150000	ug/kg	5100
cis-1,3-Dichloropropene	ND	150000	ug/kg	4900
trans-1,3-Dichloropropene	ND	150000	ug/kg	12000
Ethylbenzene	300000	150000	ug/kg	3300
Trichlorofluoromethane	ND	150000	ug/kg	9900
2-Hexanone	ND	620000	ug/kg	12000
Isopropylbenzene	9600 J	150000	ug/kg	4000
Methyl acetate	ND	310000	ug/kg	15000
Methylcyclohexane	25000 J	310000	ug/kg	7400
Methylene chloride	ND	150000	ug/kg	48000
4-Methyl-2-pentanone	ND	620000	ug/kg	30000
Naphthalene	49000 J,B	150000	ug/kg	4100

(Continued on next page)

Brown and Caldwell

Client Sample ID: GP-57, 4-8'

GC/MS Volatiles

Lot-Sample #...: A0K230408-003 Work Order #...: MAFPF1AD Matrix.....: SO

PARAMETER	RESULT	REPORTING		
		LIMIT	UNITS	MDL
Styrene	ND	150000	ug/kg	3500
1,1,2,2-Tetrachloroethane	ND	150000	ug/kg	5500
Tetrachloroethene	13000 J	150000	ug/kg	7400
Toluene	1600000	150000	ug/kg	11000
1,2,4-Trichloro-benzene	ND	150000	ug/kg	4500
1,1,1-Trichloroethane	160000	150000	ug/kg	13000
1,1,2-Trichloroethane	ND	150000	ug/kg	7400
Trichloroethene	20000 J	150000	ug/kg	6000
1,1,2-Trichloro-1,2,2-trifluoroethane	ND	150000	ug/kg	24000
1,2,4-Trimethylbenzene	25000 J	150000	ug/kg	3100
1,3,5-Trimethylbenzene	8400 J	150000	ug/kg	3600
Vinyl chloride	ND	150000	ug/kg	11000
Xylenes (total)	1300000	310000	ug/kg	5000
Methyl tert-butyl ether	ND	620000	ug/kg	4400
SURROGATE	PERCENT		RECOVERY	
	RECOVERY	LIMITS		
Dibromofluoromethane	12 DIL, *	(30 - 122)		
1,2-Dichloroethane-d4	20 DIL, *	(39 - 128)		
Toluene-d8	19 DIL, *	(33 - 134)		
4-Bromofluorobenzene	36 DIL	(26 - 141)		

NOTE(S):

DIL The concentration is estimated or not reported due to dilution or the presence of interfering analytes.

* Surrogate recovery is outside stated control limits.

Results and reporting limits have been adjusted for dry weight.

J Estimated result. Result is less than RL.

B Method blank contamination. The associated method blank contains the target analyte at a reportable level.

Brown and Caldwell

GP-57, 4-8'

GC/MS Volatiles

Lot-Sample #: A0K230408-003

Work Order #: MAFPF1AD

Matrix: SO

MASS SPECTROMETER/DATA SYSTEM (MSDS) TENTATIVELY IDENTIFIED COMPOUNDS

<u>PARAMETER</u>	<u>CAS #</u>	<u>ESTIMATED RESULT</u>	<u>RETENTION TIME</u>	<u>UNITS</u>
Hexane		910000	Q 4.339	ug/kg

NOTE(S):

Q: Result was quantitated against the response factor of a calibration standard.

Brown and Caldwell

Client Sample ID: GP-57, 4-8'

GC/MS Semivolatiles

Lot-Sample #...: A0K230408-003 Work Order #...: MAFPF1AC Matrix.....: SO
 Date Sampled...: 11/17/10 15:10 Date Received...: 11/20/10
 Prep Date.....: 11/29/10 Analysis Date...: 12/02/10
 Prep Batch #...: 0333049
 Dilution Factor: 20
 % Moisture.....: 19 Method.....: SW846 8270C

PARAMETER	RESULT	REPORTING		
		LIMIT	UNITS	MDL
Acenaphthene	950	540	ug/kg	82
Acenaphthylene	8800	540	ug/kg	82
Acetophenone	ND	8000	ug/kg	230
Anthracene	8500	540	ug/kg	82
Atrazine	ND	16000	ug/kg	230
Benzo(a)anthracene	32000	540	ug/kg	82
Benzo(a)pyrene	79000	540	ug/kg	82
Benzo(b)fluoranthene	67000	540	ug/kg	82
Benzo(ghi)perylene	100000	540	ug/kg	82
Benzo(k)fluoranthene	25000	540	ug/kg	82
Benzaldehyde	ND	8000	ug/kg	300
1,1'-Biphenyl	2400 J	4000	ug/kg	670
bis(2-Chloroethoxy) methane	ND	8000	ug/kg	540
bis(2-Chloroethyl)- ether	ND	8000	ug/kg	50
bis(2-Ethylhexyl) phthalate	4000	4000	ug/kg	470
4-Bromophenyl phenyl ether	ND	4000	ug/kg	320
Butyl benzyl phthalate	ND	4000	ug/kg	250
Caprolactam	ND	27000	ug/kg	920
Carbazole	ND	4000	ug/kg	670
4-Chloroaniline	ND	12000	ug/kg	420
4-Chloro-3-methylphenol	ND	12000	ug/kg	520
2-Chloronaphthalene	ND	4000	ug/kg	82
2-Chlorophenol	ND	4000	ug/kg	670
4-Chlorophenyl phenyl ether	ND	4000	ug/kg	320
Chrysene	42000	540	ug/kg	27
Dibenz(a,h)anthracene	13000	540	ug/kg	82
Dibenzofuran	ND	4000	ug/kg	82
3,3'-Dichlorobenzidine	ND	8000	ug/kg	450
2,4-Dichlorophenol	ND	12000	ug/kg	500
Diethyl phthalate	ND	4000	ug/kg	400
2,4-Dimethylphenol	ND	12000	ug/kg	500
Dimethyl phthalate	ND	4000	ug/kg	420
Di-n-butyl phthalate	ND	4000	ug/kg	370

(Continued on next page)

Brown and Caldwell

Client Sample ID: GP-57, 4-8'

GC/MS Semivolatiles

Lot-Sample #...: A0K230408-003

Work Order #...: MAFPF1AC

Matrix.....: SO

PARAMETER	RESULT	REPORTING		
		LIMIT	UNITS	MDL
4,6-Dinitro- 2-methylphenol	ND	12000	ug/kg	2000
2,4-Dinitrophenol	ND	27000	ug/kg	2000
2,4-Dinitrotoluene	ND	16000	ug/kg	670
2,6-Dinitrotoluene	ND	16000	ug/kg	520
Di-n-octyl phthalate	ND	4000	ug/kg	670
Fluoranthene	38000	540	ug/kg	82
Fluorene	4600	540	ug/kg	82
Hexachlorobenzene	ND	540	ug/kg	52
Hexachlorobutadiene	ND	4000	ug/kg	670
Hexachlorocyclopenta- diene	ND	27000	ug/kg	670
Hexachloroethane	ND	4000	ug/kg	220
Indeno(1,2,3-cd)pyrene	60000	540	ug/kg	82
Isophorone	1100 J	4000	ug/kg	320
2-Methylnaphthalene	6700	540	ug/kg	82
2-Methylphenol	ND	16000	ug/kg	2000
4-Methylphenol	ND	16000	ug/kg	2000
Naphthalene	3700 B	540	ug/kg	82
2-Nitroaniline	ND	16000	ug/kg	230
3-Nitroaniline	ND	16000	ug/kg	400
4-Nitroaniline	ND	16000	ug/kg	640
Nitrobenzene	ND	8000	ug/kg	54
2-Nitrophenol	ND	4000	ug/kg	670
4-Nitrophenol	ND	27000	ug/kg	2000
N-Nitrosodi-n-propyl- amine	ND	4000	ug/kg	670
N-Nitrosodiphenylamine	ND	4000	ug/kg	520
2,2'-oxybis (1-Chloropropane)	ND	8000	ug/kg	240
Pentachlorophenol	ND	12000	ug/kg	2000
Phenanthrene	35000	540	ug/kg	82
Phenol	ND	4000	ug/kg	670
Pyrene	86000	540	ug/kg	82
2,4,5-Trichloro- phenol	ND	12000	ug/kg	620
2,4,6-Trichloro- phenol	ND	12000	ug/kg	2000

(Continued on next page)

Brown and Caldwell

Client Sample ID: GP-57, 4-8'

GC/MS Semivolatiles

Lot-Sample #...: A0K230408-003 Work Order #...: MAFPF1AC Matrix.....: SO

<u>SURROGATE</u>	<u>PERCENT RECOVERY</u>	<u>RECOVERY LIMITS</u>
Nitrobenzene-d5	108 DIL	(24 - 112)
2-Fluorobiphenyl	90 DIL	(34 - 110)
Terphenyl-d14	109 DIL	(41 - 119)
Phenol-d5	82 DIL	(28 - 110)
2-Fluorophenol	74 DIL	(26 - 110)
2,4,6-Tribromophenol	57 DIL	(10 - 118)

NOTE(S):

DIL The concentration is estimated or not reported due to dilution or the presence of interfering analytes.

Results and reporting limits have been adjusted for dry weight.

J Estimated result. Result is less than RL.

B Method blank contamination. The associated method blank contains the target analyte at a reportable level.

Brown and Caldwell

GP-57, 4-8'

GC/MS Semivolatiles

Lot-Sample #: A0K230408-003

Work Order #: MAFPF1AC

Matrix: SO

MASS SPECTROMETER/DATA SYSTEM (MSDS) TENTATIVELY IDENTIFIED COMPOUNDS

PARAMETER	CAS #	ESTIMATED		RETENTION		UNITS
		RESULT		TIME		
Unknown Aromatic		140000 J	M	2.7616		ug/kg
Unknown Aromatic		58000 J	M	2.9326		ug/kg
Unknown		17000 J	M	7.5375		ug/kg
Unknown		14000 J	M	7.9168		ug/kg
Unknown PAH		9900 J	M	8.0984		ug/kg
Unknown PAH		11000 J	M	8.3014		ug/kg
Unknown PAH		21000 J	M	8.3709		ug/kg
Unknown PAH		13000 J	M	8.4617		ug/kg
Unknown PAH		14000 J	M	8.5312		ug/kg
Unknown		13000 J	M	8.5525		ug/kg
Unknown		14000 J	M	8.7555		ug/kg
Unknown		12000 J	M	8.8463		ug/kg
Unknown PAH		11000 J	M	8.8677		ug/kg
Unknown PAH		18000 J	M	8.8891		ug/kg
Unknown		12000 J	M	8.9104		ug/kg
Unknown		36000 J	M	9.1508		ug/kg
Unknown PAH		17000 J	M	9.3432		ug/kg
Unknown		30000 J	M	9.4607		ug/kg
Unknown		14000 J	M	9.7919		ug/kg
Unknown		10000 J	M	9.8613		ug/kg
Unknown PAH		23000 J	M	10.048		ug/kg
Unknown PAH		75000 J	M	10.24		ug/kg
Unknown PAH		25000 J	M	10.384		ug/kg
Unknown		18000 J	M	10.887		ug/kg
Unknown		11000 J	M	11.415		ug/kg
Unknown		27000 J	M	11.602		ug/kg

NOTE(S):

M: Result was measured against nearest internal standard assuming a response factor of 1.

Brown and Caldwell

Client Sample ID: GP-57, 4-8'

GC Semivolatiles

Lot-Sample #...: A0K230408-003 Work Order #...: MAFPF1AE Matrix.....: SO
Date Sampled...: 11/17/10 15:10 Date Received..: 11/20/10
Prep Date.....: 12/02/10 Analysis Date..: 12/03/10
Prep Batch #...: 0336049
Dilution Factor: 1
% Moisture.....: 19 Method.....: SW846 8082

PARAMETER	RESULT	REPORTING		
		LIMIT	UNITS	MDL
Aroclor 1016	ND	41	ug/kg	26
Aroclor 1221	ND	41	ug/kg	20
Aroclor 1232	ND	41	ug/kg	17
Aroclor 1242	250	41	ug/kg	16
Aroclor 1248	ND	41	ug/kg	21
Aroclor 1254	410	41	ug/kg	21
Aroclor 1260	ND	41	ug/kg	21
SURROGATE	PERCENT		RECOVERY	
	RECOVERY		LIMITS	
Tetrachloro-m-xylene	92		(10 - 196)	
Decachlorobiphenyl	133		(10 - 199)	

NOTE(S):

Results and reporting limits have been adjusted for dry weight.

Brown and Caldwell

Client Sample ID: GP-57, 4-8'

General Chemistry

Lot-Sample #...: A0K230408-003 Work Order #...: MAFPF Matrix.....: SO
Date Sampled...: 11/17/10 15:10 Date Received..: 11/20/10
% Moisture.....: 19

<u>PARAMETER</u>	<u>RESULT</u>	<u>RL</u>	<u>UNITS</u>	<u>METHOD</u>	<u>PREPARATION- ANALYSIS DATE</u>	<u>PREP BATCH #</u>
Percent Solids	80.8	10.0	%	MCAWW 160.3 MOD	12/01-12/02/10	0335256
		Dilution Factor: 1		MDL.....: 10.0		

Brown and Caldwell

Client Sample ID: GP-80, 12-15'

GC/MS Volatiles

Lot-Sample #...: A0K230408-004 Work Order #...: MAFPG1AC Matrix.....: SO
 Date Sampled...: 11/19/10 11:03 Date Received...: 11/20/10
 Prep Date.....: 11/30/10 Analysis Date...: 12/01/10
 Prep Batch #...: 0336449
 Dilution Factor: 5
 % Moisture.....: 17 Method.....: SW846 8260B

PARAMETER	RESULT	REPORTING		
		LIMIT	UNITS	MDL
Acetone	ND	6000	ug/kg	1000
Benzene	480 J	1500	ug/kg	73
Bromodichloromethane	ND	1500	ug/kg	60
Bromoform	ND	1500	ug/kg	110
Bromomethane	ND	1500	ug/kg	180
2-Butanone	650 J	6000	ug/kg	260
Carbon disulfide	ND	1500	ug/kg	73
Carbon tetrachloride	ND	1500	ug/kg	39
Chlorobenzene	ND	1500	ug/kg	39
Dibromochloromethane	ND	1500	ug/kg	73
1,2-Dibromo-3-chloro- propane	ND	3000	ug/kg	300
Chloroethane	ND	1500	ug/kg	370
Chloroform	ND	1500	ug/kg	53
Chloromethane	ND	1500	ug/kg	85
Cyclohexane	ND	3000	ug/kg	240
1,2-Dibromoethane	ND	1500	ug/kg	60
1,2-Dichlorobenzene	3700	1500	ug/kg	52
1,3-Dichlorobenzene	51 J	1500	ug/kg	29
1,4-Dichlorobenzene	350 J,B	1500	ug/kg	48
Dichlorodifluoromethane	ND	1500	ug/kg	97
1,1-Dichloroethane	ND	1500	ug/kg	100
1,2-Dichloroethane	ND	1500	ug/kg	60
1,1-Dichloroethene	ND	1500	ug/kg	110
cis-1,2-Dichloroethene	670 J	1500	ug/kg	42
trans-1,2-Dichloroethene	ND	1500	ug/kg	56
1,2-Dichloropropane	ND	1500	ug/kg	50
cis-1,3-Dichloropropene	ND	1500	ug/kg	48
trans-1,3-Dichloropropene	ND	1500	ug/kg	120
Ethylbenzene	19000	1500	ug/kg	33
Trichlorofluoromethane	ND	1500	ug/kg	97
2-Hexanone	ND	6000	ug/kg	120
Isopropylbenzene	2700	1500	ug/kg	39
Methyl acetate	ND	3000	ug/kg	150
Methylcyclohexane	230 J	3000	ug/kg	73
Methylene chloride	ND	1500	ug/kg	470
4-Methyl-2-pentanone	ND	6000	ug/kg	290
Naphthalene	3900 B	1500	ug/kg	41

(Continued on next page)

Brown and Caldwell

Client Sample ID: GP-80, 12-15'

GC/MS Volatiles

Lot-Sample #...: A0K230408-004 Work Order #...: MAFPG1AC Matrix.....: SO

PARAMETER	RESULT	REPORTING		
		LIMIT	UNITS	MDL
Styrene	ND	1500	ug/kg	34
1,1,2,2-Tetrachloroethane	ND	1500	ug/kg	54
Tetrachloroethene	92 J	1500	ug/kg	73
Toluene	5500	1500	ug/kg	100
1,2,4-Trichloro-benzene	120 J	1500	ug/kg	44
1,1,1-Trichloroethane	ND	1500	ug/kg	130
1,1,2-Trichloroethane	ND	1500	ug/kg	73
Trichloroethene	330 J	1500	ug/kg	59
1,1,2-Trichloro-1,2,2-trifluoroethane	ND	1500	ug/kg	240
1,2,4-Trimethylbenzene	45000	1500	ug/kg	30
1,3,5-Trimethylbenzene	14000	1500	ug/kg	35
Vinyl chloride	ND	1500	ug/kg	110
Xylenes (total)	85000	3000	ug/kg	49
Methyl tert-butyl ether	ND	6000	ug/kg	43
SURROGATE	PERCENT		RECOVERY	
	RECOVERY		LIMITS	
Dibromofluoromethane	60 DIL		(30 - 122)	
1,2-Dichloroethane-d4	71 DIL		(39 - 128)	
Toluene-d8	66 DIL		(33 - 134)	
4-Bromofluorobenzene	92 DIL		(26 - 141)	

NOTE(S):

DIL The concentration is estimated or not reported due to dilution or the presence of interfering analytes.

Results and reporting limits have been adjusted for dry weight.

J Estimated result. Result is less than RL.

B Method blank contamination. The associated method blank contains the target analyte at a reportable level.

Brown and Caldwell

GP-80, 12-15'

GC/MS Volatiles

Lot-Sample #: A0K230408-004

Work Order #: MAFPG1AC

Matrix: SO

MASS SPECTROMETER/DATA SYSTEM (MSDS) TENTATIVELY IDENTIFIED COMPOUNDS

PARAMETER	CAS #	ESTIMATED		RETENTION		UNITS
		RESULT		TIME		
Nonane	111-84-2	31000 NJ	M	9.5459		ug/kg
Benzene, 1-ethyl-4-methyl-	622-96-8	19000 NJ	M	10.587		ug/kg
Cyclohexane, 1,3-dimethyl-,	638-04-0	10000 NJ	M	10.634		ug/kg
Decane	124-18-5	35000 NJ	M	10.67		ug/kg
Benzene, 1-ethyl-2-methyl-	611-14-3	10000 NJ	M	10.823		ug/kg
Cyclohexane, butyl-	1678-93-9	16000 NJ	M	11.167		ug/kg
Benzene, 1-methyl-3-propyl-	1074-43-7	11000 NJ	M	11.51		ug/kg
Benzene, 1-methyl-2-(1-meth	527-84-4	20000 NJ	M	11.569		ug/kg
Undecane	1120-21-4	14000 NJ	M	11.664		ug/kg
Benzene, 1-methyl-4-(1-meth	99-87-6	8900 NJ	M	11.817		ug/kg
Hexane		16000	Q	4.339		ug/kg
n-Propylbenzene		6500	Q	10.504		ug/kg
sec-Butylbenzene		2900	Q	11.119		ug/kg
4-Isopropyltoluene		6600	Q	11.238		ug/kg
n-Butylbenzene		8600	Q	11.581		ug/kg
2-Methylnaphthalene		4100	Q	14.006		ug/kg
1,2,3-Trimethylbenzene		14000	Q	11.32		ug/kg

NOTE(S):

Q: Result was quantitated against the response factor of a calibration standard.

M: Result was measured against nearest internal standard assuming a response factor of 1.

Brown and Caldwell

Client Sample ID: GP-80, 12-15'

GC/MS Semivolatiles

Lot-Sample #...: A0K230408-004 Work Order #...: MAFPG1AE Matrix.....: SO
 Date Sampled...: 11/19/10 11:03 Date Received...: 11/20/10
 Prep Date.....: 12/02/10 Analysis Date...: 12/08/10
 Prep Batch #...: 0336061
 Dilution Factor: 20
 % Moisture.....: 17 Method.....: SW846 8270C

PARAMETER	RESULT	REPORTING		
		LIMIT	UNITS	MDL
Acenaphthene	ND	160	ug/kg	80
Acenaphthylene	ND	160	ug/kg	80
Acetophenone	ND	2400	ug/kg	220
Anthracene	ND	160	ug/kg	80
Atrazine	ND	4800	ug/kg	220
Benzo(a)anthracene	ND	160	ug/kg	80
Benzo(a)pyrene	220	160	ug/kg	80
Benzo(b)fluoranthene	520	160	ug/kg	80
Benzo(ghi)perylene	630	160	ug/kg	80
Benzo(k)fluoranthene	ND	160	ug/kg	80
Benzaldehyde	ND	2400	ug/kg	290
1,1'-Biphenyl	ND	1200	ug/kg	650
bis(2-Chloroethoxy) methane	ND	2400	ug/kg	530
bis(2-Chloroethyl)- ether	ND	2400	ug/kg	48
bis(2-Ethylhexyl) phthalate	3700 B	1200	ug/kg	460
4-Bromophenyl phenyl ether	ND	1200	ug/kg	310
Butyl benzyl phthalate	920 J	1200	ug/kg	240
Caprolactam	ND	8000	ug/kg	890
Carbazole	ND	1200	ug/kg	650
4-Chloroaniline	ND	3600	ug/kg	410
4-Chloro-3-methylphenol	ND	3600	ug/kg	510
2-Chloronaphthalene	ND	1200	ug/kg	80
2-Chlorophenol	ND	1200	ug/kg	650
4-Chlorophenyl phenyl ether	ND	1200	ug/kg	310
Chrysene	320	160	ug/kg	27
Dibenz(a,h)anthracene	ND	160	ug/kg	80
Dibenzofuran	ND	1200	ug/kg	80
3,3'-Dichlorobenzidine	ND	2400	ug/kg	440
2,4-Dichlorophenol	ND	3600	ug/kg	480
Diethyl phthalate	ND	1200	ug/kg	390
2,4-Dimethylphenol	ND	3600	ug/kg	480
Dimethyl phthalate	ND	1200	ug/kg	410
Di-n-butyl phthalate	ND	1200	ug/kg	360

(Continued on next page)

Brown and Caldwell

Client Sample ID: GP-80, 12-15'

GC/MS Semivolatiles

Lot-Sample #...: A0K230408-004 Work Order #...: MAFPG1AE Matrix.....: SO

PARAMETER	RESULT	REPORTING		
		LIMIT	UNITS	MDL
4,6-Dinitro- 2-methylphenol	ND	3600	ug/kg	1900
2,4-Dinitrophenol	ND	8000	ug/kg	1900
2,4-Dinitrotoluene	ND	4800	ug/kg	650
2,6-Dinitrotoluene	ND	4800	ug/kg	510
Di-n-octyl phthalate	ND	1200	ug/kg	650
Fluoranthene	290	160	ug/kg	80
Fluorene	ND	160	ug/kg	80
Hexachlorobenzene	ND	160	ug/kg	51
Hexachlorobutadiene	ND	1200	ug/kg	650
Hexachlorocyclopenta- diene	ND	8000	ug/kg	650
Hexachloroethane	ND	1200	ug/kg	220
Indeno(1,2,3-cd)pyrene	330	160	ug/kg	80
Isophorone	ND	1200	ug/kg	310
2-Methylnaphthalene	3100	160	ug/kg	80
2-Methylphenol	ND	4800	ug/kg	1900
4-Methylphenol	ND	4800	ug/kg	1900
Naphthalene	2600	160	ug/kg	80
2-Nitroaniline	ND	4800	ug/kg	220
3-Nitroaniline	ND	4800	ug/kg	390
4-Nitroaniline	ND	4800	ug/kg	630
Nitrobenzene	ND	2400	ug/kg	53
2-Nitrophenol	ND	1200	ug/kg	650
4-Nitrophenol	ND	8000	ug/kg	1900
N-Nitrosodi-n-propyl- amine	ND	1200	ug/kg	650
N-Nitrosodiphenylamine	ND	1200	ug/kg	510
2,2'-oxybis (1-Chloropropane)	ND	2400	ug/kg	230
Pentachlorophenol	ND	3600	ug/kg	1900
Phenanthrene	270	160	ug/kg	80
Phenol	ND	1200	ug/kg	650
Pyrene	470	160	ug/kg	80
2,4,5-Trichloro- phenol	ND	3600	ug/kg	600
2,4,6-Trichloro- phenol	ND	3600	ug/kg	1900

(Continued on next page)

Brown and Caldwell

Client Sample ID: GP-80, 12-15'

GC/MS Semivolatiles

Lot-Sample #...: A0K230408-004 Work Order #...: MAFPG1AE Matrix.....: SO

<u>SURROGATE</u>	<u>PERCENT RECOVERY</u>	<u>RECOVERY LIMITS</u>
Nitrobenzene-d5	127 DIL, *	(24 - 112)
2-Fluorobiphenyl	59 DIL	(34 - 110)
Terphenyl-d14	75 DIL	(41 - 119)
Phenol-d5	52 DIL	(28 - 110)
2-Fluorophenol	52 DIL	(26 - 110)
2,4,6-Tribromophenol	48 DIL	(10 - 118)

NOTE(S):

DIL The concentration is estimated or not reported due to dilution or the presence of interfering analytes.

* Surrogate recovery is outside stated control limits.

Results and reporting limits have been adjusted for dry weight.

B Method blank contamination. The associated method blank contains the target analyte at a reportable level.

J Estimated result. Result is less than RL.

Brown and Caldwell

GP-80, 12-15'

GC/MS Semivolatiles

Lot-Sample #: A0K230408-004

Work Order #: MAFPG1AE

Matrix: SO

MASS SPECTROMETER/DATA SYSTEM (MSDS) TENTATIVELY IDENTIFIED COMPOUNDS

PARAMETER	CAS #	ESTIMATED		RETENTION	
		RESULT		TIME	UNITS
Unknown Aromatic		14000 J	M	2.6779	ug/kg
Unknown Aromatic		3700 J	M	3.1646	ug/kg
Unknown Aromatic		5600 J	M	3.2074	ug/kg
Unknown Aromatic		3500 J	M	3.309	ug/kg
Unknown Aromatic		11000 J	M	3.3999	ug/kg
Unknown		9200 J	M	3.4962	ug/kg
Unknown Aromatic		7600 J	M	3.5551	ug/kg
Unknown		3600 J	M	3.6085	ug/kg
Unknown Hydrocarbon		5900 J	M	3.6727	ug/kg
Unknown Aromatic		9500 J	M	3.6888	ug/kg
Unknown Hydrocarbon		5400 J	M	3.7476	ug/kg
Unknown Aromatic		4000 J	M	3.8385	ug/kg
Unknown Aromatic		11000 J	M	3.8706	ug/kg
Unknown Aromatic		9200 J	M	3.9455	ug/kg
Unknown Aromatic		3900 J	M	3.9723	ug/kg
Unknown Aromatic		3800 J	M	4.0364	ug/kg
Unknown		3000 J	M	4.0525	ug/kg
Unknown		3200 J	M	4.122	ug/kg
Unknown Hydrocarbon		4100 J	M	4.1541	ug/kg
Unknown Hydrocarbon		2700 J	M	4.1969	ug/kg
Unknown		4800 J	M	4.2183	ug/kg
Unknown Hydrocarbon		5000 J	M	4.3627	ug/kg
Unknown Hydrocarbon		6000 J	M	5.5875	ug/kg
Unknown Hydrocarbon		3900 J	M	5.9512	ug/kg

NOTE(S):

M: Result was measured against nearest internal standard assuming a response factor of 1.

Brown and Caldwell

Client Sample ID: GP-80, 12-15'

GC Semivolatiles

Lot-Sample #...: A0K230408-004 Work Order #...: MAFPG1AD Matrix.....: SO
Date Sampled...: 11/19/10 11:03 Date Received..: 11/20/10
Prep Date.....: 12/02/10 Analysis Date..: 12/03/10
Prep Batch #...: 0336049
Dilution Factor: 1
% Moisture.....: 17 Method.....: SW846 8082

<u>PARAMETER</u>	<u>RESULT</u>	<u>REPORTING</u>		
		<u>LIMIT</u>	<u>UNITS</u>	<u>MDL</u>
Aroclor 1016	ND	40	ug/kg	25
Aroclor 1221	ND	40	ug/kg	19
Aroclor 1232	ND	40	ug/kg	17
Aroclor 1242	ND	40	ug/kg	16
Aroclor 1248	ND	40	ug/kg	21
Aroclor 1254	150	40	ug/kg	21
Aroclor 1260	ND	40	ug/kg	21

<u>SURROGATE</u>	<u>PERCENT</u>	<u>RECOVERY</u>
	<u>RECOVERY</u>	<u>LIMITS</u>
Tetrachloro-m-xylene	77	(10 - 196)
Decachlorobiphenyl	60	(10 - 199)

NOTE(S):

Results and reporting limits have been adjusted for dry weight.

Brown and Caldwell

Client Sample ID: GP-80, 12-15'

General Chemistry

Lot-Sample #...: A0K230408-004 Work Order #...: MAFPG Matrix.....: SO
Date Sampled...: 11/19/10 11:03 Date Received..: 11/20/10
% Moisture.....: 17

<u>PARAMETER</u>	<u>RESULT</u>	<u>RL</u>	<u>UNITS</u>	<u>METHOD</u>	<u>PREPARATION- ANALYSIS DATE</u>	<u>PREP BATCH #</u>
Percent Solids	82.7	10.0	%	MCAWW 160.3 MOD	12/01-12/02/10	0335256
		Dilution Factor: 1		MDL.....: 10.0		

Brown and Caldwell

Client Sample ID: GP-75, 8-10'

GC/MS Volatiles

Lot-Sample #...: A0K230408-005 Work Order #...: MAFPL1AD Matrix.....: SO
 Date Sampled...: 11/18/10 15:42 Date Received...: 11/20/10
 Prep Date.....: 11/30/10 Analysis Date...: 12/01/10
 Prep Batch #...: 0336449
 Dilution Factor: 0.99
 % Moisture.....: 14 Method.....: SW846 8260B

PARAMETER	RESULT	REPORTING		
		LIMIT	UNITS	MDL
Acetone	ND	1200	ug/kg	200
Benzene	ND	290	ug/kg	14
Bromodichloromethane	ND	290	ug/kg	11
Bromoform	ND	290	ug/kg	22
Bromomethane	ND	290	ug/kg	34
2-Butanone	ND	1200	ug/kg	50
Carbon disulfide	ND	290	ug/kg	14
Carbon tetrachloride	ND	290	ug/kg	7.4
Chlorobenzene	ND	290	ug/kg	7.4
Dibromochloromethane	ND	290	ug/kg	14
1,2-Dibromo-3-chloro- propane	ND	580	ug/kg	58
Chloroethane	ND	290	ug/kg	71
Chloroform	ND	290	ug/kg	10
Chloromethane	ND	290	ug/kg	16
Cyclohexane	ND	580	ug/kg	46
1,2-Dibromoethane	ND	290	ug/kg	12
1,2-Dichlorobenzene	170 J	290	ug/kg	9.9
1,3-Dichlorobenzene	ND	290	ug/kg	5.6
1,4-Dichlorobenzene	11 J,B	290	ug/kg	9.3
Dichlorodifluoromethane	ND	290	ug/kg	19
1,1-Dichloroethane	ND	290	ug/kg	20
1,2-Dichloroethane	ND	290	ug/kg	12
1,1-Dichloroethene	ND	290	ug/kg	21
cis-1,2-Dichloroethene	120 J	290	ug/kg	8.0
trans-1,2-Dichloroethene	ND	290	ug/kg	11
1,2-Dichloropropane	ND	290	ug/kg	9.5
cis-1,3-Dichloropropene	ND	290	ug/kg	9.1
trans-1,3-Dichloropropene	ND	290	ug/kg	23
Ethylbenzene	1600	290	ug/kg	6.2
Trichlorofluoromethane	ND	290	ug/kg	19
2-Hexanone	ND	1200	ug/kg	23
Isopropylbenzene	200 J	290	ug/kg	7.5
Methyl acetate	55 J	580	ug/kg	29
Methylcyclohexane	98 J	580	ug/kg	14
Methylene chloride	ND	290	ug/kg	89
4-Methyl-2-pentanone	ND	1200	ug/kg	56
Naphthalene	1100 B	290	ug/kg	7.8

(Continued on next page)

Brown and Caldwell

Client Sample ID: GP-75, 8-10'

GC/MS Volatiles

Lot-Sample #...: A0K230408-005 Work Order #...: MAFPL1AD Matrix.....: SO

PARAMETER	RESULT	REPORTING		
		LIMIT	UNITS	MDL
Styrene	ND	290	ug/kg	6.5
1,1,2,2-Tetrachloroethane	ND	290	ug/kg	10
Tetrachloroethene	50 J	290	ug/kg	14
Toluene	1400	290	ug/kg	20
1,2,4-Trichloro-benzene	22 J	290	ug/kg	8.4
1,1,1-Trichloroethane	72 J	290	ug/kg	24
1,1,2-Trichloroethane	ND	290	ug/kg	14
Trichloroethene	44 J	290	ug/kg	11
1,1,2-Trichloro-1,2,2-trifluoroethane	ND	290	ug/kg	45
1,2,4-Trimethylbenzene	2600	290	ug/kg	5.8
1,3,5-Trimethylbenzene	750	290	ug/kg	6.7
Vinyl chloride	ND	290	ug/kg	21
Xylenes (total)	11000	580	ug/kg	9.4
Methyl tert-butyl ether	ND	1200	ug/kg	8.2

SURROGATE	PERCENT		RECOVERY	
	RECOVERY		LIMITS	
Dibromofluoromethane	71		(30 - 122)	
1,2-Dichloroethane-d4	77		(39 - 128)	
Toluene-d8	73		(33 - 134)	
4-Bromofluorobenzene	66		(26 - 141)	

NOTE(S):

Results and reporting limits have been adjusted for dry weight.

J Estimated result. Result is less than RL.

B Method blank contamination. The associated method blank contains the target analyte at a reportable level.

Brown and Caldwell

GP-75, 8-10'

GC/MS Volatiles

Lot-Sample #: A0K230408-005

Work Order #: MAFPL1AD

Matrix: SO

MASS SPECTROMETER/DATA SYSTEM (MSDS) TENTATIVELY IDENTIFIED COMPOUNDS

PARAMETER	CAS #	ESTIMATED		RETENTION		UNITS
		RESULT		TIME		
Nonane	111-84-2	2200 NJ	M	9.546		ug/kg
Benzene, 1-ethyl-4-methyl-	622-96-8	1700 NJ	M	10.575		ug/kg
Decane	124-18-5	5100 NJ	M	10.658		ug/kg
Benzene, 1-ethyl-2-methyl-	611-14-3	930 NJ	M	10.823		ug/kg
Cyclohexane, butyl-	1678-93-9	1300 NJ	M	11.167		ug/kg
Unknown		1200 J	M	11.498		ug/kg
Undecane	1120-21-4	3100 NJ	M	11.664		ug/kg
Benzene, 1-methyl-4-propyl-	1074-55-1	870 NJ	M	11.723		ug/kg
Unknown		1000 J	M	11.817		ug/kg
Benzene, 1-ethyl-2,4-dimeth	874-41-9	1000 NJ	M	11.877		ug/kg
Hexane		760	Q	4.327		ug/kg
n-Propylbenzene		330	Q	10.504		ug/kg
1,2,3-Trimethylbenzene		790	Q	11.32		ug/kg

NOTE(S):

Q: Result was quantitated against the response factor of a calibration standard.

M: Result was measured against nearest internal standard assuming a response factor of 1.

Brown and Caldwell

Client Sample ID: GP-75, 8-10'

GC/MS Semivolatiles

Lot-Sample #...: A0K230408-005 Work Order #...: MAFPL1AC Matrix.....: SO
 Date Sampled...: 11/18/10 15:42 Date Received...: 11/20/10
 Prep Date.....: 11/29/10 Analysis Date...: 12/01/10
 Prep Batch #...: 0333049
 Dilution Factor: 2
 % Moisture.....: 14 Method.....: SW846 8270C

PARAMETER	RESULT	REPORTING		
		LIMIT	UNITS	MDL
Acenaphthene	16	16	ug/kg	7.7
Acenaphthylene	35	16	ug/kg	7.7
Acetophenone	ND	230	ug/kg	22
Anthracene	17	16	ug/kg	7.7
Atrazine	ND	470	ug/kg	21
Benzo(a)anthracene	86	16	ug/kg	7.7
Benzo(a)pyrene	69	16	ug/kg	7.7
Benzo(b)fluoranthene	250	16	ug/kg	7.7
Benzo(ghi)perylene	500	16	ug/kg	7.7
Benzo(k)fluoranthene	95	16	ug/kg	7.7
Benzaldehyde	ND	230	ug/kg	28
1,1'-Biphenyl	110 J	120	ug/kg	63
bis(2-Chloroethoxy) methane	ND	230	ug/kg	51
bis(2-Chloroethyl)- ether	ND	230	ug/kg	4.7
bis(2-Ethylhexyl) phthalate	2700	120	ug/kg	44
4-Bromophenyl phenyl ether	ND	120	ug/kg	30
Butyl benzyl phthalate	ND	120	ug/kg	23
Caprolactam	ND	770	ug/kg	86
Carbazole	ND	120	ug/kg	63
4-Chloroaniline	ND	350	ug/kg	40
4-Chloro-3-methylphenol	ND	350	ug/kg	49
2-Chloronaphthalene	ND	120	ug/kg	7.7
2-Chlorophenol	ND	120	ug/kg	63
4-Chlorophenyl phenyl ether	ND	120	ug/kg	30
Chrysene	180	16	ug/kg	2.6
Dibenz(a,h)anthracene	37	16	ug/kg	7.7
Dibenzofuran	ND	120	ug/kg	7.7
3,3'-Dichlorobenzidine	ND	230	ug/kg	42
2,4-Dichlorophenol	ND	350	ug/kg	47
Diethyl phthalate	ND	120	ug/kg	37
2,4-Dimethylphenol	300 J	350	ug/kg	47
Dimethyl phthalate	ND	120	ug/kg	40
Di-n-butyl phthalate	ND	120	ug/kg	35

(Continued on next page)

Brown and Caldwell

Client Sample ID: GP-75, 8-10'

GC/MS Semivolatiles

Lot-Sample #...: A0K230408-005 Work Order #...: MAFPL1AC Matrix.....: SO

PARAMETER	RESULT	REPORTING		
		LIMIT	UNITS	MDL
4,6-Dinitro- 2-methylphenol	ND	350	ug/kg	190
2,4-Dinitrophenol	ND	770	ug/kg	190
2,4-Dinitrotoluene	ND	470	ug/kg	63
2,6-Dinitrotoluene	ND	470	ug/kg	49
Di-n-octyl phthalate	ND	120	ug/kg	63
Fluoranthene	280	16	ug/kg	7.7
Fluorene	41	16	ug/kg	7.7
Hexachlorobenzene	ND	16	ug/kg	4.9
Hexachlorobutadiene	ND	120	ug/kg	63
Hexachlorocyclopenta- diene	ND	770	ug/kg	63
Hexachloroethane	ND	120	ug/kg	21
Indeno(1,2,3-cd)pyrene	230	16	ug/kg	7.7
Isophorone	ND	120	ug/kg	30
2-Methylnaphthalene	240	16	ug/kg	7.7
2-Methylphenol	1100	470	ug/kg	190
4-Methylphenol	990 #	470	ug/kg	190
Naphthalene	580 B	16	ug/kg	7.7
2-Nitroaniline	ND	470	ug/kg	21
3-Nitroaniline	ND	470	ug/kg	37
4-Nitroaniline	ND	470	ug/kg	61
Nitrobenzene	ND	230	ug/kg	5.1
2-Nitrophenol	ND	120	ug/kg	63
4-Nitrophenol	ND	770	ug/kg	190
N-Nitrosodi-n-propyl- amine	ND	120	ug/kg	63
N-Nitrosodiphenylamine	ND	120	ug/kg	49
2,2'-oxybis (1-Chloropropane)	ND	230	ug/kg	22
Pentachlorophenol	ND	350	ug/kg	190
Phenanthrene	320	16	ug/kg	7.7
Phenol	ND	120	ug/kg	63
Pyrene	430	16	ug/kg	7.7
2,4,5-Trichloro- phenol	ND	350	ug/kg	58
2,4,6-Trichloro- phenol	ND	350	ug/kg	190

(Continued on next page)

Brown and Caldwell

Client Sample ID: GP-75, 8-10'

GC/MS Semivolatiles

Lot-Sample #...: A0K230408-005 Work Order #...: MAFPL1AC Matrix.....: SO

<u>SURROGATE</u>	<u>PERCENT RECOVERY</u>	<u>RECOVERY LIMITS</u>
Nitrobenzene-d5	69 DIL	(24 - 112)
2-Fluorobiphenyl	62 DIL	(34 - 110)
Terphenyl-d14	79 DIL	(41 - 119)
Phenol-d5	59 DIL	(28 - 110)
2-Fluorophenol	63 DIL	(26 - 110)
2,4,6-Tribromophenol	57 DIL	(10 - 118)

NOTE(S):

DIL The concentration is estimated or not reported due to dilution or the presence of interfering analytes.

Results and reporting limits have been adjusted for dry weight.

J Estimated result. Result is less than RL.

This value represents a probable combination of 3-Methylphenol (m-cresol) and 4-methylphenol (p-cresol).

B Method blank contamination. The associated method blank contains the target analyte at a reportable level.

Brown and Caldwell

GP-75, 8-10'

GC/MS Semivolatiles

Lot-Sample #: A0K230408-005

Work Order #: MAFPL1AC

Matrix: SO

MASS SPECTROMETER/DATA SYSTEM (MSDS) TENTATIVELY IDENTIFIED COMPOUNDS

PARAMETER	CAS #	ESTIMATED		RETENTION	
		RESULT		TIME	UNITS
Unknown Aldol Condensate		2100 JA	M	2.5379	ug/kg
Unknown Aromatic		7000 J	M	2.7837	ug/kg
Unknown Aromatic		2700 J	M	2.9493	ug/kg
Unknown Aromatic		450 J	M	3.3606	ug/kg
Unknown Aromatic		570 J	M	3.4034	ug/kg
Unknown Aromatic		660 J	M	3.4247	ug/kg
Unknown Aromatic		400 J	M	3.4515	ug/kg
Unknown Hydrocarbon		2400 J	M	3.6117	ug/kg
Unknown Aromatic		450 J	M	3.7987	ug/kg
Unknown Aromatic		660 J	M	3.9483	ug/kg
Unknown Aromatic		530 J	M	3.9803	ug/kg
Unknown Aromatic		400 J	M	4.1459	ug/kg
Unknown Hydrocarbon		1600 J	M	4.178	ug/kg
Unknown		740 J	M	4.5145	ug/kg
Unknown Hydrocarbon		550 J	M	4.6801	ug/kg
Benzenepropanenitrile	645-59-0	2100 NJ	M	5.5883	ug/kg
Unknown		1400 J	M	7.0521	ug/kg
Unknown Organic Acid		760 J	M	7.442	ug/kg
Unknown		250 J	M	8.1044	ug/kg
Unknown Hydrocarbon		370 J	M	8.3716	ug/kg
Unknown Hydrocarbon		360 J	M	8.4624	ug/kg
Unknown		270 J	M	8.5585	ug/kg
Unknown Hydrocarbon		360 J	M	8.7028	ug/kg
Unknown Hydrocarbon		480 J	M	8.863	ug/kg
Unknown Hydrocarbon		280 J	M	9.1836	ug/kg
Unknown Hydrocarbon		370 J	M	9.4453	ug/kg

NOTE(S):

M: Result was measured against nearest internal standard assuming a response factor of 1.

Brown and Caldwell

Client Sample ID: GP-75, 8-10'

GC Semivolatiles

Lot-Sample #...: A0K230408-005 Work Order #...: MAFPL1AE Matrix.....: SO
Date Sampled...: 11/18/10 15:42 Date Received..: 11/20/10
Prep Date.....: 12/02/10 Analysis Date..: 12/03/10
Prep Batch #...: 0336049
Dilution Factor: 1
% Moisture.....: 14 Method.....: SW846 8082

PARAMETER	RESULT	REPORTING		
		LIMIT	UNITS	MDL
Aroclor 1016	ND	39	ug/kg	25
Aroclor 1221	ND	39	ug/kg	19
Aroclor 1232	ND	39	ug/kg	16
Aroclor 1242	250	39	ug/kg	15
Aroclor 1248	ND	39	ug/kg	20
Aroclor 1254	310	39	ug/kg	20
Aroclor 1260	ND	39	ug/kg	20

SURROGATE	PERCENT		RECOVERY	
	RECOVERY		LIMITS	
Tetrachloro-m-xylene	77		(10 - 196)	
Decachlorobiphenyl	108		(10 - 199)	

NOTE(S):

Results and reporting limits have been adjusted for dry weight.

Brown and Caldwell

Client Sample ID: GP-75, 8-10'

General Chemistry

Lot-Sample #...: A0K230408-005 Work Order #...: MAFPL Matrix.....: SO
Date Sampled...: 11/18/10 15:42 Date Received..: 11/20/10
% Moisture.....: 14

<u>PARAMETER</u>	<u>RESULT</u>	<u>RL</u>	<u>UNITS</u>	<u>METHOD</u>	<u>PREPARATION- ANALYSIS DATE</u>	<u>PREP BATCH #</u>
Percent Solids	85.6	10.0	%	MCAWW 160.3 MOD	12/01-12/02/10	0335256
		Dilution Factor: 1		MDL.....: 10.0		

Brown and Caldwell

Client Sample ID: GP-56, 8-9'

GC/MS Volatiles

Lot-Sample #...: A0K230408-006 Work Order #...: MAFPN1AD Matrix.....: SO
 Date Sampled...: 11/17/10 14:39 Date Received...: 11/20/10
 Prep Date.....: 11/30/10 Analysis Date...: 12/01/10
 Prep Batch #...: 0336449
 Dilution Factor: 9.96
 % Moisture.....: 8.2 Method.....: SW846 8260B

PARAMETER	RESULT	REPORTING		
		LIMIT	UNITS	MDL
Acetone	ND	11000	ug/kg	1800
Benzene	ND	2700	ug/kg	130
Bromodichloromethane	ND	2700	ug/kg	110
Bromoform	ND	2700	ug/kg	210
Bromomethane	ND	2700	ug/kg	310
2-Butanone	ND	11000	ug/kg	470
Carbon disulfide	ND	2700	ug/kg	130
Carbon tetrachloride	ND	2700	ug/kg	69
Chlorobenzene	ND	2700	ug/kg	69
Dibromochloromethane	ND	2700	ug/kg	130
1,2-Dibromo-3-chloro- propane	ND	5400	ug/kg	540
Chloroethane	ND	2700	ug/kg	660
Chloroform	ND	2700	ug/kg	95
Chloromethane	ND	2700	ug/kg	150
Cyclohexane	ND	5400	ug/kg	430
1,2-Dibromoethane	ND	2700	ug/kg	110
1,2-Dichlorobenzene	750 J	2700	ug/kg	93
1,3-Dichlorobenzene	ND	2700	ug/kg	52
1,4-Dichlorobenzene	ND	2700	ug/kg	87
Dichlorodifluoromethane	ND	2700	ug/kg	170
1,1-Dichloroethane	ND	2700	ug/kg	180
1,2-Dichloroethane	ND	2700	ug/kg	110
1,1-Dichloroethene	ND	2700	ug/kg	200
cis-1,2-Dichloroethene	160 J	2700	ug/kg	75
trans-1,2-Dichloroethene	ND	2700	ug/kg	100
1,2-Dichloropropane	ND	2700	ug/kg	89
cis-1,3-Dichloropropene	ND	2700	ug/kg	86
trans-1,3-Dichloropropene	ND	2700	ug/kg	220
Ethylbenzene	12000	2700	ug/kg	59
Trichlorofluoromethane	ND	2700	ug/kg	170
2-Hexanone	ND	11000	ug/kg	220
Isopropylbenzene	250 J	2700	ug/kg	71
Methyl acetate	ND	5400	ug/kg	270
Methylcyclohexane	220 J	5400	ug/kg	130
Methylene chloride	ND	2700	ug/kg	840
4-Methyl-2-pentanone	ND	11000	ug/kg	520
Naphthalene	86000 B	2700	ug/kg	73

(Continued on next page)

Brown and Caldwell

Client Sample ID: GP-56, 8-9'

GC/MS Volatiles

Lot-Sample #...: A0K230408-006 Work Order #...: MAFPN1AD Matrix.....: SO

PARAMETER	RESULT	REPORTING		
		LIMIT	UNITS	MDL
Styrene	ND	2700	ug/kg	61
1,1,2,2-Tetrachloroethane	ND	2700	ug/kg	97
Tetrachloroethene	220 J	2700	ug/kg	130
Toluene	32000	2700	ug/kg	180
1,2,4-Trichloro-benzene	ND	2700	ug/kg	79
1,1,1-Trichloroethane	ND	2700	ug/kg	230
1,1,2-Trichloroethane	ND	2700	ug/kg	130
Trichloroethene	ND	2700	ug/kg	110
1,1,2-Trichloro-1,2,2-trifluoroethane	ND	2700	ug/kg	420
1,2,4-Trimethylbenzene	4400	2700	ug/kg	54
1,3,5-Trimethylbenzene	1500 J	2700	ug/kg	63
Vinyl chloride	ND	2700	ug/kg	200
Xylenes (total)	43000	5400	ug/kg	88
Methyl tert-butyl ether	ND	11000	ug/kg	77

SURROGATE	PERCENT		RECOVERY	
	RECOVERY		LIMITS	
Dibromofluoromethane	66	DIL	(30 - 122)	
1,2-Dichloroethane-d4	79	DIL	(39 - 128)	
Toluene-d8	78	DIL	(33 - 134)	
4-Bromofluorobenzene	74	DIL	(26 - 141)	

NOTE(S):

DIL The concentration is estimated or not reported due to dilution or the presence of interfering analytes.

Results and reporting limits have been adjusted for dry weight.

J Estimated result. Result is less than RL.

B Method blank contamination. The associated method blank contains the target analyte at a reportable level.

Brown and Caldwell

GP-56, 8-9'

GC/MS Volatiles

Lot-Sample #: A0K230408-006

Work Order #: MAFPN1AD

Matrix: SO

MASS SPECTROMETER/DATA SYSTEM (MSDS) TENTATIVELY IDENTIFIED COMPOUNDS

PARAMETER	CAS #	ESTIMATED		RETENTION		UNITS
		RESULT		TIME		
Benzene, 1-ethyl-4-methyl-	622-96-8	4200 NJ	M	10.587		ug/kg
Unknown		4700 J	M	11.664		ug/kg
Benzene, 2-ethyl-1,4-dimeth	1758-88-9	3100 NJ	M	12.61		ug/kg
Benzene, (1-methyl-2-cyclop	65051-83-4	3300 NJ	M	12.764		ug/kg
Naphthalene, 1-methyl-	90-12-0	24000 NJ	M	14.148		ug/kg
Biphenyl	92-52-4	7900 NJ	M	14.574		ug/kg
Naphthalene, 2,6-dimethyl-	581-42-0	5600 NJ	M	14.858		ug/kg
Hexane		6500	Q	4.339		ug/kg
2-Methylnaphthalene		60000	Q	14.006		ug/kg

NOTE(S):

Q: Result was quantitated against the response factor of a calibration standard.

M: Result was measured against nearest internal standard assuming a response factor of 1.

Brown and Caldwell

Client Sample ID: GP-56, 8-9'

GC/MS Semivolatiles

Lot-Sample #...: A0K230408-006 Work Order #...: MAFPN1AC Matrix.....: SO
 Date Sampled...: 11/17/10 14:39 Date Received...: 11/20/10
 Prep Date.....: 11/29/10 Analysis Date...: 12/04/10
 Prep Batch #...: 0333049
 Dilution Factor: 2.5
 % Moisture.....: 8.2 Method.....: SW846 8270C

PARAMETER	RESULT	REPORTING		
		LIMIT	UNITS	MDL
Acenaphthene	120	18	ug/kg	9.0
Acenaphthylene	160	18	ug/kg	9.0
Acetophenone	ND	270	ug/kg	25
Anthracene	360	18	ug/kg	9.0
Atrazine	ND	540	ug/kg	25
Benzo(a)anthracene	280	18	ug/kg	9.0
Benzo(a)pyrene	300	18	ug/kg	9.0
Benzo(b)fluoranthene	260	18	ug/kg	9.0
Benzo(ghi)perylene	240	18	ug/kg	9.0
Benzo(k)fluoranthene	100	18	ug/kg	9.0
Benzaldehyde	ND	270	ug/kg	33
1,1'-Biphenyl	220	140	ug/kg	74
bis(2-Chloroethoxy) methane	ND	270	ug/kg	60
bis(2-Chloroethyl)- ether	ND	270	ug/kg	5.4
bis(2-Ethylhexyl) phthalate	89 J	140	ug/kg	52
4-Bromophenyl phenyl ether	ND	140	ug/kg	35
Butyl benzyl phthalate	ND	140	ug/kg	27
Caprolactam	ND	900	ug/kg	100
Carbazole	ND	140	ug/kg	74
4-Chloroaniline	ND	410	ug/kg	46
4-Chloro-3-methylphenol	ND	410	ug/kg	57
2-Chloronaphthalene	ND	140	ug/kg	9.0
2-Chlorophenol	ND	140	ug/kg	74
4-Chlorophenyl phenyl ether	ND	140	ug/kg	35
Chrysene	320	18	ug/kg	3.0
Dibenz(a,h)anthracene	34	18	ug/kg	9.0
Dibenzofuran	ND	140	ug/kg	9.0
3,3'-Dichlorobenzidine	ND	270	ug/kg	49
2,4-Dichlorophenol	ND	410	ug/kg	54
Diethyl phthalate	ND	140	ug/kg	44
2,4-Dimethylphenol	ND	410	ug/kg	54
Dimethyl phthalate	ND	140	ug/kg	46
Di-n-butyl phthalate	ND	140	ug/kg	41

(Continued on next page)

Brown and Caldwell

Client Sample ID: GP-56, 8-9'

GC/MS Semivolatiles

Lot-Sample #...: A0K230408-006 Work Order #...: MAFPN1AC Matrix.....: SO

PARAMETER	RESULT	REPORTING LIMIT	UNITS	MDL
4,6-Dinitro- 2-methylphenol	ND	410	ug/kg	220
2,4-Dinitrophenol	ND	900	ug/kg	220
2,4-Dinitrotoluene	ND	540	ug/kg	74
2,6-Dinitrotoluene	ND	540	ug/kg	57
Di-n-octyl phthalate	ND	140	ug/kg	74
Fluoranthene	1100	18	ug/kg	9.0
Fluorene	560	18	ug/kg	9.0
Hexachlorobenzene	ND	18	ug/kg	5.7
Hexachlorobutadiene	ND	140	ug/kg	74
Hexachlorocyclopenta- diene	ND	900	ug/kg	74
Hexachloroethane	ND	140	ug/kg	25
Indeno(1,2,3-cd)pyrene	150	18	ug/kg	9.0
Isophorone	ND	140	ug/kg	35
2-Methylnaphthalene	510	18	ug/kg	9.0
2-Methylphenol	ND	540	ug/kg	220
4-Methylphenol	ND	540	ug/kg	220
Naphthalene	330 B	18	ug/kg	9.0
2-Nitroaniline	ND	540	ug/kg	25
3-Nitroaniline	ND	540	ug/kg	44
4-Nitroaniline	ND	540	ug/kg	71
Nitrobenzene	ND	270	ug/kg	6.0
2-Nitrophenol	ND	140	ug/kg	74
4-Nitrophenol	ND	900	ug/kg	220
N-Nitrosodi-n-propyl- amine	ND	140	ug/kg	74
N-Nitrosodiphenylamine	ND	140	ug/kg	57
2,2'-oxybis (1-Chloropropane)	ND	270	ug/kg	26
Pentachlorophenol	ND	410	ug/kg	220
Phenanthrene	3100	18	ug/kg	9.0
Phenol	ND	140	ug/kg	74
Pyrene	1700	18	ug/kg	9.0
2,4,5-Trichloro- phenol	ND	410	ug/kg	68
2,4,6-Trichloro- phenol	ND	410	ug/kg	220

(Continued on next page)

Brown and Caldwell

Client Sample ID: GP-56, 8-9'

GC/MS Semivolatiles

Lot-Sample #...: A0K230408-006 Work Order #...: MAFPN1AC Matrix.....: SO

<u>SURROGATE</u>	<u>PERCENT RECOVERY</u>	<u>RECOVERY LIMITS</u>
Nitrobenzene-d5	49 DIL	(24 - 112)
2-Fluorobiphenyl	53 DIL	(34 - 110)
Terphenyl-d14	73 DIL	(41 - 119)
Phenol-d5	55 DIL	(28 - 110)
2-Fluorophenol	58 DIL	(26 - 110)
2,4,6-Tribromophenol	41 DIL	(10 - 118)

NOTE(S) :

DIL The concentration is estimated or not reported due to dilution or the presence of interfering analytes.

Results and reporting limits have been adjusted for dry weight.

J Estimated result. Result is less than RL.

B Method blank contamination. The associated method blank contains the target analyte at a reportable level.

Brown and Caldwell

GP-56, 8-9'

GC/MS Semivolatiles

Lot-Sample #: A0K230408-006

Work Order #: MAFPN1AC

Matrix: SO

MASS SPECTROMETER/DATA SYSTEM (MSDS) TENTATIVELY IDENTIFIED COMPOUNDS

PARAMETER	CAS #	ESTIMATED	RETENTION		UNITS
		RESULT	TIME		
Unknown Aldol Condensate		8600 J	M 2.5229		ug/kg
Naphthalene, 1-methyl-	90-12-0	340 NJ	M 5.3061		ug/kg
Unknown PAH		140 J	M 5.6854		ug/kg
Unknown PAH		220 J	M 5.7442		ug/kg
Unknown		140 J	M 5.7602		ug/kg
Unknown Hydrocarbon		150 J	M 6.2784		ug/kg
Unknown PAH		150 J	M 6.7913		ug/kg
Dibenzothiophene	132-65-0	150 NJ	M 7.0103		ug/kg
Unknown		150 J	M 7.1919		ug/kg
Unknown PAH		250 J	M 7.443		ug/kg
Unknown PAH		240 J	M 7.4644		ug/kg
Unknown PAH		700 J	M 7.5338		ug/kg
2-Phenylnaphthalene	35465-71-5	220 NJ	M 7.6513		ug/kg
Unknown		190 J	M 7.8597		ug/kg
Unknown		240 J	M 8.0306		ug/kg
Unknown PAH		120 J	M 8.3725		ug/kg
Unknown		77 J	M 8.3939		ug/kg
Unknown PAH		85 J	M 8.4206		ug/kg
Unknown PAH		81 J	M 8.5435		ug/kg
Unknown PAH		88 J	M 8.8533		ug/kg
Unknown PAH		75 J	M 8.8747		ug/kg
Unknown PAH		190 J	M 10.21		ug/kg

NOTE(S):

M: Result was measured against nearest internal standard assuming a response factor of 1.

Brown and Caldwell

Client Sample ID: GP-56, 8-9'

GC Semivolatiles

Lot-Sample #...: A0K230408-006 Work Order #...: MAFPN1AE Matrix.....: SO
Date Sampled...: 11/17/10 14:39 Date Received...: 11/20/10
Prep Date.....: 12/02/10 Analysis Date...: 12/03/10
Prep Batch #...: 0336049
Dilution Factor: 1
% Moisture.....: 8.2 Method.....: SW846 8082

		REPORTING		
<u>PARAMETER</u>	<u>RESULT</u>	<u>LIMIT</u>	<u>UNITS</u>	<u>MDL</u>
Aroclor 1016	ND	36	ug/kg	23
Aroclor 1221	ND	36	ug/kg	17
Aroclor 1232	ND	36	ug/kg	15
Aroclor 1242	ND	36	ug/kg	14
Aroclor 1248	ND	36	ug/kg	19
Aroclor 1254	ND	36	ug/kg	19
Aroclor 1260	ND	36	ug/kg	19
	PERCENT	RECOVERY		
<u>SURROGATE</u>	<u>RECOVERY</u>	<u>LIMITS</u>		
Tetrachloro-m-xylene	91	(10 - 196)		
Decachlorobiphenyl	95	(10 - 199)		

NOTE(S):

Results and reporting limits have been adjusted for dry weight.

Brown and Caldwell

Client Sample ID: GP-56, 8-9'

General Chemistry

Lot-Sample #...: A0K230408-006 Work Order #...: MAFPN Matrix.....: SO
Date Sampled...: 11/17/10 14:39 Date Received..: 11/20/10
% Moisture.....: 8.2

<u>PARAMETER</u>	<u>RESULT</u>	<u>RL</u>	<u>UNITS</u>	<u>METHOD</u>	<u>PREPARATION- ANALYSIS DATE</u>	<u>PREP BATCH #</u>
Percent Solids	91.8	10.0	%	MCAWW 160.3 MOD	12/01-12/02/10	0335256
		Dilution Factor: 1		MDL.....: 10.0		

Brown and Caldwell

Client Sample ID: GP-54, 4-8'

GC/MS Volatiles

Lot-Sample #...: A0K230408-007 Work Order #...: MAFPP1AC Matrix.....: SO
 Date Sampled...: 11/17/10 13:38 Date Received...: 11/20/10
 Prep Date.....: 11/30/10 Analysis Date...: 12/01/10
 Prep Batch #...: 0336449
 Dilution Factor: 3.29
 % Moisture.....: 9.8 Method.....: SW846 8260B

PARAMETER	RESULT	REPORTING		
		LIMIT	UNITS	MDL
Acetone	820 J	3600	ug/kg	620
Benzene	ND	910	ug/kg	44
Bromodichloromethane	ND	910	ug/kg	36
Bromoform	ND	910	ug/kg	69
Bromomethane	ND	910	ug/kg	110
2-Butanone	520 J	3600	ug/kg	160
Carbon disulfide	150 J	910	ug/kg	44
Carbon tetrachloride	ND	910	ug/kg	23
Chlorobenzene	ND	910	ug/kg	23
Dibromochloromethane	ND	910	ug/kg	44
1,2-Dibromo-3-chloro- propane	ND	1800	ug/kg	180
Chloroethane	ND	910	ug/kg	220
Chloroform	ND	910	ug/kg	32
Chloromethane	ND	910	ug/kg	51
Cyclohexane	160 J	1800	ug/kg	150
1,2-Dibromoethane	ND	910	ug/kg	36
1,2-Dichlorobenzene	460 J	910	ug/kg	31
1,3-Dichlorobenzene	63 J	910	ug/kg	18
1,4-Dichlorobenzene	170 J,B	910	ug/kg	29
Dichlorodifluoromethane	ND	910	ug/kg	58
1,1-Dichloroethane	ND	910	ug/kg	62
1,2-Dichloroethane	ND	910	ug/kg	36
1,1-Dichloroethene	400 J	910	ug/kg	66
cis-1,2-Dichloroethene	1100	910	ug/kg	25
trans-1,2-Dichloroethene	ND	910	ug/kg	34
1,2-Dichloropropane	ND	910	ug/kg	30
cis-1,3-Dichloropropene	ND	910	ug/kg	29
trans-1,3-Dichloropropene	ND	910	ug/kg	73
Ethylbenzene	320 J	910	ug/kg	20
Trichlorofluoromethane	ND	910	ug/kg	58
2-Hexanone	ND	3600	ug/kg	73
Isopropylbenzene	53 J	910	ug/kg	24
Methyl acetate	210 J	1800	ug/kg	91
Methylcyclohexane	280 J	1800	ug/kg	44
Methylene chloride	ND	910	ug/kg	280
4-Methyl-2-pentanone	ND	3600	ug/kg	180
Naphthalene	230 J,B	910	ug/kg	24

(Continued on next page)

Brown and Caldwell

Client Sample ID: GP-54, 4-8'

GC/MS Volatiles

Lot-Sample #...: A0K230408-007 Work Order #...: MAFPP1AC Matrix.....: SO

PARAMETER	RESULT	REPORTING		
		LIMIT	UNITS	MDL
Styrene	ND	910	ug/kg	20
1,1,2,2-Tetrachloroethane	ND	910	ug/kg	32
Tetrachloroethene	11000	910	ug/kg	44
Toluene	430 J	910	ug/kg	62
1,2,4-Trichloro-benzene	140 J	910	ug/kg	27
1,1,1-Trichloroethane	17000	910	ug/kg	77
1,1,2-Trichloroethane	ND	910	ug/kg	44
Trichloroethene	17000	910	ug/kg	35
1,1,2-Trichloro-1,2,2-trifluoroethane	ND	910	ug/kg	140
1,2,4-Trimethylbenzene	1100	910	ug/kg	18
1,3,5-Trimethylbenzene	1200	910	ug/kg	21
Vinyl chloride	ND	910	ug/kg	66
Xylenes (total)	6600	1800	ug/kg	30
Methyl tert-butyl ether	ND	3600	ug/kg	26

SURROGATE	PERCENT	RECOVERY
	RECOVERY	LIMITS
Dibromofluoromethane	73 DIL	(30 - 122)
1,2-Dichloroethane-d4	75 DIL	(39 - 128)
Toluene-d8	69 DIL	(33 - 134)
4-Bromofluorobenzene	71 DIL	(26 - 141)

NOTE(S):

DIL The concentration is estimated or not reported due to dilution or the presence of interfering analytes.

Results and reporting limits have been adjusted for dry weight.

J Estimated result. Result is less than RL.

B Method blank contamination. The associated method blank contains the target analyte at a reportable level.

Brown and Caldwell

GP-54, 4-8'

GC/MS Volatiles

Lot-Sample #: A0K230408-007

Work Order #: MAFPP1AC

Matrix: SO

MASS SPECTROMETER/DATA SYSTEM (MSDS) TENTATIVELY IDENTIFIED COMPOUNDS

PARAMETER	CAS #	ESTIMATED		RETENTION		UNITS
		RESULT		TIME		
Unknown		1900 J	M	10.078		ug/kg
Benzene, 1-ethyl-4-methyl-	622-96-8	2600 NJ	M	10.587		ug/kg
Benzene, 1-ethyl-2-methyl-	611-14-3	2500 NJ	M	10.824		ug/kg
Benzene, 1,3-diethyl-	141-93-5	1900 NJ	M	11.486		ug/kg
Undecane	1120-21-4	2600 NJ	M	11.664		ug/kg
Benzene, 1-methyl-4-propyl-	1074-55-1	1500 NJ	M	11.723		ug/kg
Unknown		1500 J	M	11.818		ug/kg
Benzene, 2-ethyl-1,3-dimeth	2870-04-4	1800 NJ	M	11.877		ug/kg
Benzene, 1-ethyl-2,4-dimeth	874-41-9	1500 NJ	M	11.995		ug/kg
Benzene, 1-methyl-2-(2-prop	1587-04-8	1400 NJ	M	12.622		ug/kg

NOTE(S):

M: Result was measured against nearest internal standard assuming a response factor of 1.

Brown and Caldwell

Client Sample ID: GP-54, 4-8'

GC/MS Semivolatiles

Lot-Sample #...: A0K230408-007 Work Order #...: MAFPP1AE Matrix.....: SO
 Date Sampled...: 11/17/10 13:38 Date Received...: 11/20/10
 Prep Date.....: 12/02/10 Analysis Date...: 12/08/10
 Prep Batch #...: 0336061
 Dilution Factor: 10
 % Moisture.....: 9.8 Method.....: SW846 8270C

PARAMETER	RESULT	REPORTING		
		LIMIT	UNITS	MDL
Acenaphthene	ND	74	ug/kg	37
Acenaphthylene	2400	74	ug/kg	37
Acetophenone	ND	1100	ug/kg	100
Anthracene	510	74	ug/kg	37
Atrazine	ND	2200	ug/kg	100
Benzo(a)anthracene	2100	74	ug/kg	37
Benzo(a)pyrene	3600	74	ug/kg	37
Benzo(b)fluoranthene	4100	74	ug/kg	37
Benzo(ghi)perylene	6300	74	ug/kg	37
Benzo(k)fluoranthene	1500	74	ug/kg	37
Benzaldehyde	ND	1100	ug/kg	130
1,1'-Biphenyl	ND	550	ug/kg	300
bis(2-Chloroethoxy) methane	ND	1100	ug/kg	240
bis(2-Chloroethyl)- ether	ND	1100	ug/kg	22
bis(2-Ethylhexyl) phthalate	2400 B	550	ug/kg	210
4-Bromophenyl phenyl ether	ND	550	ug/kg	140
Butyl benzyl phthalate	470 J	550	ug/kg	110
Caprolactam	ND	3700	ug/kg	410
Carbazole	ND	550	ug/kg	300
4-Chloroaniline	ND	1700	ug/kg	190
4-Chloro-3-methylphenol	ND	1700	ug/kg	230
2-Chloronaphthalene	ND	550	ug/kg	37
2-Chlorophenol	ND	550	ug/kg	300
4-Chlorophenyl phenyl ether	ND	550	ug/kg	140
Chrysene	2500	74	ug/kg	12
Dibenz(a,h)anthracene	ND	74	ug/kg	37
Dibenzofuran	ND	550	ug/kg	37
3,3'-Dichlorobenzidine	ND	1100	ug/kg	200
2,4-Dichlorophenol	ND	1700	ug/kg	220
Diethyl phthalate	ND	550	ug/kg	180
2,4-Dimethylphenol	ND	1700	ug/kg	220
Dimethyl phthalate	ND	550	ug/kg	190
Di-n-butyl phthalate	ND	550	ug/kg	170

(Continued on next page)

Brown and Caldwell

Client Sample ID: GP-54, 4-8'

GC/MS Semivolatiles

Lot-Sample #...: A0K230408-007

Work Order #...: MAFPP1AE

Matrix.....: SO

PARAMETER	RESULT	REPORTING		
		LIMIT	UNITS	MDL
4,6-Dinitro- 2-methylphenol	ND	1700	ug/kg	890
2,4-Dinitrophenol	ND	3700	ug/kg	890
2,4-Dinitrotoluene	ND	2200	ug/kg	300
2,6-Dinitrotoluene	ND	2200	ug/kg	230
Di-n-octyl phthalate	ND	550	ug/kg	300
Fluoranthene	2900	74	ug/kg	37
Fluorene	190	74	ug/kg	37
Hexachlorobenzene	ND	74	ug/kg	23
Hexachlorobutadiene	ND	550	ug/kg	300
Hexachlorocyclopenta- diene	ND	3700	ug/kg	300
Hexachloroethane	ND	550	ug/kg	100
Indeno(1,2,3-cd)pyrene	3500	74	ug/kg	37
Isophorone	ND	550	ug/kg	140
2-Methylnaphthalene	140	74	ug/kg	37
2-Methylphenol	ND	2200	ug/kg	890
4-Methylphenol	ND	2200	ug/kg	890
Naphthalene	120	74	ug/kg	37
2-Nitroaniline	ND	2200	ug/kg	100
3-Nitroaniline	ND	2200	ug/kg	180
4-Nitroaniline	ND	2200	ug/kg	290
Nitrobenzene	ND	1100	ug/kg	24
2-Nitrophenol	ND	550	ug/kg	300
4-Nitrophenol	ND	3700	ug/kg	890
N-Nitrosodi-n-propyl- amine	ND	550	ug/kg	300
N-Nitrosodiphenylamine	ND	550	ug/kg	230
2,2'-oxybis (1-Chloropropane)	ND	1100	ug/kg	110
Pentachlorophenol	ND	1700	ug/kg	890
Phenanthrene	580	74	ug/kg	37
Phenol	ND	550	ug/kg	300
Pyrene	6000	74	ug/kg	37
2,4,5-Trichloro- phenol	ND	1700	ug/kg	280
2,4,6-Trichloro- phenol	ND	1700	ug/kg	890

(Continued on next page)

Brown and Caldwell

Client Sample ID: GP-54, 4-8'

GC/MS Semivolatiles

Lot-Sample #...: A0K230408-007 Work Order #...: MAFPP1AE Matrix.....: SO

<u>SURROGATE</u>	<u>PERCENT RECOVERY</u>	<u>RECOVERY LIMITS</u>
Nitrobenzene-d5	60 DIL	(24 - 112)
2-Fluorobiphenyl	62 DIL	(34 - 110)
Terphenyl-d14	73 DIL	(41 - 119)
Phenol-d5	57 DIL	(28 - 110)
2-Fluorophenol	64 DIL	(26 - 110)
2,4,6-Tribromophenol	66 DIL	(10 - 118)

NOTE(S) :

DIL The concentration is estimated or not reported due to dilution or the presence of interfering analytes.

Results and reporting limits have been adjusted for dry weight.

B Method blank contamination. The associated method blank contains the target analyte at a reportable level.

J Estimated result. Result is less than RL.

Brown and Caldwell

GP-54, 4-8'

GC/MS Semivolatiles

Lot-Sample #: A0K230408-007

Work Order #: MAFPP1AE

Matrix: SO

MASS SPECTROMETER/DATA SYSTEM (MSDS) TENTATIVELY IDENTIFIED COMPOUNDS

PARAMETER	CAS #	ESTIMATED		RETENTION		UNITS
		RESULT		TIME		
Unknown Aldol Condensate		6800	JA	M	2.4587	ug/kg
Unknown Aromatic		1100	J	M	3.3947	ug/kg
Unknown		1100	J	M	3.6889	ug/kg
Unknown		1400	J	M	3.7103	ug/kg
Unknown Hydrocarbon		3200	J	M	3.8921	ug/kg
Unknown Hydrocarbon		980	J	M	4.7961	ug/kg
Unknown PAH		1100	J	M	5.47	ug/kg
Unknown Hydrocarbon		780	J	M	6.6253	ug/kg
Unknown Hydrocarbon		900	J	M	6.9355	ug/kg
Unknown		650	J	M	7.1174	ug/kg
Unknown		660	J	M	7.2564	ug/kg
Unknown Hydrocarbon		320	J	M	7.7913	ug/kg
Unknown		560	J	M	8.0801	ug/kg
Unknown PAH		300	J	M	8.2352	ug/kg
Unknown		340	J	M	8.5989	ug/kg
Unknown		500	J	M	8.8664	ug/kg
Unknown PAH		4300	J	M	10.021	ug/kg

NOTE(S):

M: Result was measured against nearest internal standard assuming a response factor of 1.

Brown and Caldwell

Client Sample ID: GP-54, 4-8'

GC Semivolatiles

Lot-Sample #...: A0K230408-007 Work Order #...: MAFPP1AD Matrix.....: SO
Date Sampled...: 11/17/10 13:38 Date Received..: 11/20/10
Prep Date.....: 12/02/10 Analysis Date..: 12/03/10
Prep Batch #...: 0336049
Dilution Factor: 1
% Moisture.....: 9.8 Method.....: SW846 8082

PARAMETER	RESULT	REPORTING		
		LIMIT	UNITS	MDL
Aroclor 1016	ND	37	ug/kg	23
Aroclor 1221	ND	37	ug/kg	18
Aroclor 1232	ND	37	ug/kg	16
Aroclor 1242	ND	37	ug/kg	14
Aroclor 1248	ND	37	ug/kg	19
Aroclor 1254	45	37	ug/kg	19
Aroclor 1260	ND	37	ug/kg	19

SURROGATE	PERCENT		RECOVERY	
	RECOVERY		LIMITS	
Tetrachloro-m-xylene	88		(10 - 196)	
Decachlorobiphenyl	78		(10 - 199)	

NOTE(S):

Results and reporting limits have been adjusted for dry weight.

Brown and Caldwell

Client Sample ID: GP-54, 4-8'

General Chemistry

Lot-Sample #...: A0K230408-007 Work Order #...: MAFPP Matrix.....: SO
Date Sampled...: 11/17/10 13:38 Date Received..: 11/20/10
% Moisture.....: 9.8

<u>PARAMETER</u>	<u>RESULT</u>	<u>RL</u>	<u>UNITS</u>	<u>METHOD</u>	<u>PREPARATION- ANALYSIS DATE</u>	<u>PREP BATCH #</u>
Percent Solids	90.2	10.0	%	MCAWW 160.3 MOD	12/01-12/02/10	0335256
		Dilution Factor: 1		MDL.....: 10.0		

Brown and Caldwell

Client Sample ID: GP-47, 4-6'

GC/MS Volatiles

Lot-Sample #...: A0K230408-008 Work Order #...: MAFPQ1AD Matrix.....: SO
 Date Sampled...: 11/17/10 09:38 Date Received...: 11/20/10
 Prep Date.....: 11/30/10 Analysis Date...: 12/01/10
 Prep Batch #...: 0336449
 Dilution Factor: 0.99
 % Moisture.....: 6.1 Method.....: SW846 8260B

PARAMETER	RESULT	REPORTING		
		LIMIT	UNITS	MDL
Acetone	ND	1100	ug/kg	180
Benzene	ND	260	ug/kg	13
Bromodichloromethane	ND	260	ug/kg	10
Bromoform	ND	260	ug/kg	20
Bromomethane	ND	260	ug/kg	31
2-Butanone	ND	1100	ug/kg	45
Carbon disulfide	ND	260	ug/kg	13
Carbon tetrachloride	ND	260	ug/kg	6.7
Chlorobenzene	ND	260	ug/kg	6.7
Dibromochloromethane	ND	260	ug/kg	13
1,2-Dibromo-3-chloro- propane	ND	530	ug/kg	53
Chloroethane	ND	260	ug/kg	64
Chloroform	ND	260	ug/kg	9.3
Chloromethane	ND	260	ug/kg	15
Cyclohexane	ND	530	ug/kg	42
1,2-Dibromoethane	ND	260	ug/kg	11
1,2-Dichlorobenzene	1800	260	ug/kg	9.1
1,3-Dichlorobenzene	41 J	260	ug/kg	5.1
1,4-Dichlorobenzene	360 B	260	ug/kg	8.4
Dichlorodifluoromethane	ND	260	ug/kg	17
1,1-Dichloroethane	ND	260	ug/kg	18
1,2-Dichloroethane	ND	260	ug/kg	11
1,1-Dichloroethene	ND	260	ug/kg	19
cis-1,2-Dichloroethene	30 J	260	ug/kg	7.3
trans-1,2-Dichloroethene	ND	260	ug/kg	9.7
1,2-Dichloropropane	ND	260	ug/kg	8.6
cis-1,3-Dichloropropene	ND	260	ug/kg	8.3
trans-1,3-Dichloropropene	ND	260	ug/kg	21
Ethylbenzene	590	260	ug/kg	5.7
Trichlorofluoromethane	ND	260	ug/kg	17
2-Hexanone	ND	1100	ug/kg	21
Isopropylbenzene	66 J	260	ug/kg	6.9
Methyl acetate	ND	530	ug/kg	26
Methylcyclohexane	25 J	530	ug/kg	13
Methylene chloride	ND	260	ug/kg	81
4-Methyl-2-pentanone	ND	1100	ug/kg	51
Naphthalene	2500 B	260	ug/kg	7.1

(Continued on next page)

Brown and Caldwell

Client Sample ID: GP-47, 4-6'

GC/MS Volatiles

Lot-Sample #...: A0K230408-008 Work Order #...: MAFPQ1AD Matrix.....: SO

PARAMETER	RESULT	REPORTING		
		LIMIT	UNITS	MDL
Styrene	ND	260	ug/kg	5.9
1,1,2,2-Tetrachloroethane	ND	260	ug/kg	9.4
Tetrachloroethene	130 J	260	ug/kg	13
Toluene	440	260	ug/kg	18
1,2,4-Trichloro-benzene	15 J	260	ug/kg	7.7
1,1,1-Trichloroethane	140 J	260	ug/kg	22
1,1,2-Trichloroethane	ND	260	ug/kg	13
Trichloroethene	1000	260	ug/kg	10
1,1,2-Trichloro-1,2,2-trifluoroethane	ND	260	ug/kg	41
1,2,4-Trimethylbenzene	720	260	ug/kg	5.3
1,3,5-Trimethylbenzene	490	260	ug/kg	6.1
Vinyl chloride	ND	260	ug/kg	19
Xylenes (total)	6300	530	ug/kg	8.5
Methyl tert-butyl ether	ND	1100	ug/kg	7.5

SURROGATE	PERCENT		RECOVERY	
	RECOVERY		LIMITS	
Dibromofluoromethane	62		(30 - 122)	
1,2-Dichloroethane-d4	72		(39 - 128)	
Toluene-d8	73		(33 - 134)	
4-Bromofluorobenzene	78		(26 - 141)	

NOTE(S):

Results and reporting limits have been adjusted for dry weight.

J Estimated result. Result is less than RL.

B Method blank contamination. The associated method blank contains the target analyte at a reportable level.

Brown and Caldwell

GP-47, 4-6'

GC/MS Volatiles

Lot-Sample #: A0K230408-008

Work Order #: MAFPQ1AD

Matrix: SO

MASS SPECTROMETER/DATA SYSTEM (MSDS) TENTATIVELY IDENTIFIED COMPOUNDS

PARAMETER	CAS #	ESTIMATED	RETENTION		UNITS
		RESULT	TIME		
Cyclohexane, 1,3,5-trimethy	1839-63-0	870 NJ	M 9.0846		ug/kg
Octane, 4-methyl-	2216-34-4	1000 NJ	M 9.1082		ug/kg
Nonane	111-84-2	2200 NJ	M 9.5461		ug/kg
Cyclohexane, 1-ethyl-2-meth	4923-78-8	840 NJ	M 9.7945		ug/kg
Benzene, 1-ethyl-2-methyl-	611-14-3	890 NJ	M 10.587		ug/kg
Decane	124-18-5	2300 NJ	M 10.658		ug/kg
Benzene, 2-butenyl-	1560-06-1	830 NJ	M 12.374		ug/kg
Benzene, 1-ethenyl-4-ethyl-	3454-07-7	930 NJ	M 12.622		ug/kg
1H-Indene, 1-methyl-	767-59-9	710 NJ	M 12.764		ug/kg
Naphthalene, 1-methyl-	90-12-0	2200 NJ	M 14.149		ug/kg
2-Methylnaphthalene		6100	Q 14.007		ug/kg
1,2,3-Trimethylbenzene		300	Q 11.321		ug/kg

NOTE(S):

Q: Result was quantitated against the response factor of a calibration standard.

M: Result was measured against nearest internal standard assuming a response factor of 1.

Brown and Caldwell

Client Sample ID: GP-47, 4-6'

GC/MS Semivolatiles

Lot-Sample #...: A0K230408-008 Work Order #...: MAFPQ1AC Matrix.....: SO
 Date Sampled...: 11/17/10 09:38 Date Received...: 11/20/10
 Prep Date.....: 11/29/10 Analysis Date...: 12/04/10
 Prep Batch #...: 0333049
 Dilution Factor: 100
 % Moisture.....: 6.1 Method.....: SW846 8270C

PARAMETER	RESULT	REPORTING		
		LIMIT	UNITS	MDL
Acenaphthene	9300	710	ug/kg	350
Acenaphthylene	36000	710	ug/kg	350
Acetophenone	ND	11000	ug/kg	980
Anthracene	20000	710	ug/kg	350
Atrazine	ND	21000	ug/kg	970
Benzo(a)anthracene	12000	710	ug/kg	350
Benzo(a)pyrene	15000	710	ug/kg	350
Benzo(b)fluoranthene	12000	710	ug/kg	350
Benzo(ghi)perylene	14000	710	ug/kg	350
Benzo(k)fluoranthene	3500	710	ug/kg	350
Benzaldehyde	ND	11000	ug/kg	1300
1,1'-Biphenyl	18000	5300	ug/kg	2900
bis(2-Chloroethoxy) methane	ND	11000	ug/kg	2300
bis(2-Chloroethyl)- ether	ND	11000	ug/kg	210
bis(2-Ethylhexyl) phthalate	ND	5300	ug/kg	2000
4-Bromophenyl phenyl ether	ND	5300	ug/kg	1400
Butyl benzyl phthalate	1800 J	5300	ug/kg	1100
Caprolactam	ND	35000	ug/kg	3900
Carbazole	ND	5300	ug/kg	2900
4-Chloroaniline	ND	16000	ug/kg	1800
4-Chloro-3-methylphenol	ND	16000	ug/kg	2200
2-Chloronaphthalene	ND	5300	ug/kg	350
2-Chlorophenol	ND	5300	ug/kg	2900
4-Chlorophenyl phenyl ether	ND	5300	ug/kg	1400
Chrysene	13000	710	ug/kg	120
Dibenz(a,h)anthracene	1300	710	ug/kg	350
Dibenzofuran	ND	5300	ug/kg	350
3,3'-Dichlorobenzidine	ND	11000	ug/kg	1900
2,4-Dichlorophenol	ND	16000	ug/kg	2100
Diethyl phthalate	ND	5300	ug/kg	1700
2,4-Dimethylphenol	ND	16000	ug/kg	2100
Dimethyl phthalate	ND	5300	ug/kg	1800
Di-n-butyl phthalate	ND	5300	ug/kg	1600

(Continued on next page)

Brown and Caldwell

Client Sample ID: GP-47, 4-6'

GC/MS Semivolatiles

Lot-Sample #...: A0K230408-008

Work Order #...: MAFPQ1AC

Matrix.....: SO

PARAMETER	RESULT	REPORTING		
		LIMIT	UNITS	MDL
4,6-Dinitro- 2-methylphenol	ND	16000	ug/kg	8500
2,4-Dinitrophenol	ND	35000	ug/kg	8500
2,4-Dinitrotoluene	ND	21000	ug/kg	2900
2,6-Dinitrotoluene	ND	21000	ug/kg	2200
Di-n-octyl phthalate	ND	5300	ug/kg	2900
Fluoranthene	48000	710	ug/kg	350
Fluorene	35000	710	ug/kg	350
Hexachlorobenzene	ND	710	ug/kg	220
Hexachlorobutadiene	ND	5300	ug/kg	2900
Hexachlorocyclopenta- diene	ND	35000	ug/kg	2900
Hexachloroethane	ND	5300	ug/kg	960
Indeno(1,2,3-cd)pyrene	8200	710	ug/kg	350
Isophorone	ND	5300	ug/kg	1400
2-Methylnaphthalene	51000	710	ug/kg	350
2-Methylphenol	ND	21000	ug/kg	8500
4-Methylphenol	ND	21000	ug/kg	8500
Naphthalene	9100 B	710	ug/kg	350
2-Nitroaniline	ND	21000	ug/kg	970
3-Nitroaniline	ND	21000	ug/kg	1700
4-Nitroaniline	ND	21000	ug/kg	2800
Nitrobenzene	ND	11000	ug/kg	230
2-Nitrophenol	ND	5300	ug/kg	2900
4-Nitrophenol	ND	35000	ug/kg	8500
N-Nitrosodi-n-propyl- amine	ND	5300	ug/kg	2900
N-Nitrosodiphenylamine	ND	5300	ug/kg	2200
2,2'-oxybis (1-Chloropropane)	ND	11000	ug/kg	1000
Pentachlorophenol	ND	16000	ug/kg	8500
Phenanthrene	120000	710	ug/kg	350
Phenol	ND	5300	ug/kg	2900
Pyrene	69000	710	ug/kg	350
2,4,5-Trichloro- phenol	ND	16000	ug/kg	2700
2,4,6-Trichloro- phenol	ND	16000	ug/kg	8500

(Continued on next page)

Brown and Caldwell

Client Sample ID: GP-47, 4-6'

GC/MS Semivolatiles

Lot-Sample #...: A0K230408-008 Work Order #...: MAFPQ1AC Matrix.....: SO

<u>SURROGATE</u>	PERCENT <u>RECOVERY</u>	RECOVERY <u>LIMITS</u>
Nitrobenzene-d5	0.0 DIL, *	(24 - 112)
2-Fluorobiphenyl	0.0 DIL, *	(34 - 110)
Terphenyl-d14	0.0 DIL, *	(41 - 119)
Phenol-d5	0.0 DIL, *	(28 - 110)
2-Fluorophenol	0.0 DIL, *	(26 - 110)
2,4,6-Tribromophenol	0.0 DIL, *	(10 - 118)

NOTE(S):

DIL The concentration is estimated or not reported due to dilution or the presence of interfering analytes.

* Surrogate recovery is outside stated control limits.

Results and reporting limits have been adjusted for dry weight.

J Estimated result. Result is less than RL.

B Method blank contamination. The associated method blank contains the target analyte at a reportable level.

Brown and Caldwell

GP-47, 4-6'

GC/MS Semivolatiles

Lot-Sample #: A0K230408-008

Work Order #: MAFPQ1AC

Matrix: SO

MASS SPECTROMETER/DATA SYSTEM (MSDS) TENTATIVELY IDENTIFIED COMPOUNDS

PARAMETER	CAS #	ESTIMATED		RETENTION		UNITS
		RESULT		TIME		
Naphthalene, 1-methyl-	90-12-0	33000 NJ	M	5.3063		ug/kg
Unknown PAH		7500 J	M	5.6375		ug/kg
Unknown PAH		5800 J	M	5.6855		ug/kg
Unknown PAH		10000 J	M	5.7443		ug/kg
Unknown		6400 J	M	5.7603		ug/kg
Unknown PAH		7600 J	M	5.7924		ug/kg
Unknown PAH		4900 J	M	5.8298		ug/kg
1,1'-Biphenyl, 4-methyl-	644-08-6	6000 NJ	M	5.974		ug/kg
Unknown Hydrocarbon		4800 J	M	6.2785		ug/kg
Unknown PAH		6500 J	M	6.7914		ug/kg
Unknown		4700 J	M	7.2882		ug/kg
Unknown		5500 J	M	7.4431		ug/kg
Unknown PAH		5800 J	M	7.4645		ug/kg
Unknown PAH		22000 J	M	7.5339		ug/kg
Unknown		10000 J	M	7.6515		ug/kg
Unknown PAH		8600 J	M	8.0361		ug/kg
Unknown PAH		4400 J	M	8.3673		ug/kg
Unknown PAH		3300 J	M	8.4207		ug/kg
Unknown PAH		3100 J	M	8.8748		ug/kg
Unknown		3200 J	M	9.1312		ug/kg
Unknown PAH		9100 J	M	10.205		ug/kg

NOTE(S):

M: Result was measured against nearest internal standard assuming a response factor of 1.

Brown and Caldwell

Client Sample ID: GP-47, 4-6'

GC Semivolatiles

Lot-Sample #...: A0K230408-008 Work Order #...: MAFPQ1AE Matrix.....: SO
Date Sampled...: 11/17/10 09:38 Date Received...: 11/20/10
Prep Date.....: 12/02/10 Analysis Date...: 12/06/10
Prep Batch #...: 0336049
Dilution Factor: 10
% Moisture.....: 6.1 Method.....: SW846 8082

		REPORTING		
<u>PARAMETER</u>	<u>RESULT</u>	<u>LIMIT</u>	<u>UNITS</u>	<u>MDL</u>
Aroclor 1016	ND	350	ug/kg	220
Aroclor 1221	ND	350	ug/kg	170
Aroclor 1232	ND	350	ug/kg	150
Aroclor 1242	ND	350	ug/kg	140
Aroclor 1248	ND	350	ug/kg	180
Aroclor 1254	ND	350	ug/kg	180
Aroclor 1260	ND	350	ug/kg	180
	PERCENT	RECOVERY		
<u>SURROGATE</u>	<u>RECOVERY</u>	<u>LIMITS</u>		
Tetrachloro-m-xylene	178 DIL	(10 - 196)		
Decachlorobiphenyl	112 DIL	(10 - 199)		

NOTE(S):

DIL The concentration is estimated or not reported due to dilution or the presence of interfering analytes.

Results and reporting limits have been adjusted for dry weight.

Elevated reporting limits. The reporting limits are elevated due to matrix interference.

Brown and Caldwell

Client Sample ID: GP-47, 4-6'

General Chemistry

Lot-Sample #...: A0K230408-008 Work Order #...: MAFPO Matrix.....: SO
Date Sampled...: 11/17/10 09:38 Date Received..: 11/20/10
% Moisture.....: 6.1

<u>PARAMETER</u>	<u>RESULT</u>	<u>RL</u>	<u>UNITS</u>	<u>METHOD</u>	<u>PREPARATION- ANALYSIS DATE</u>	<u>PREP BATCH #</u>
Percent Solids	93.9	10.0	%	MCAWW 160.3 MOD	12/01-12/02/10	0335256
		Dilution Factor: 1		MDL.....: 10.0		

Brown and Caldwell

Client Sample ID: MW-6 LNAPL

GC/MS Volatiles

Lot-Sample #...: A0K230408-009 Work Order #...: MAFPR1AA Matrix.....: LO
 Date Sampled...: 11/16/10 16:10 Date Received...: 11/20/10
 Prep Date.....: 12/02/10 Analysis Date...: 12/09/10
 Prep Batch #...: 0342315
 Dilution Factor: 842.1
 % Moisture.....: Method.....: SW846 8260B

PARAMETER	RESULT	REPORTING		
		LIMIT	UNITS	MDL
Acetone	ND	2100000	ug/kg	83000
Benzene	ND	520000	ug/kg	5400
Bromodichloromethane	ND	520000	ug/kg	10000
Bromoform	ND	520000	ug/kg	11000
Bromomethane	ND	1000000	ug/kg	21000
2-Butanone	ND	2100000	ug/kg	41000
Carbon disulfide	ND	520000	ug/kg	17000
Carbon tetrachloride	ND	520000	ug/kg	10000
Chlorobenzene	ND	520000	ug/kg	5300
Dibromochloromethane	ND	520000	ug/kg	5800
Chloroethane	ND	1000000	ug/kg	55000
Chloroform	ND	520000	ug/kg	10000
Chloromethane	ND	1000000	ug/kg	4400
Cyclohexane	ND	2100000	ug/kg	6500
1,2-Dibromo-3-chloro- propane	ND	1000000	ug/kg	51000
1,2-Dibromoethane	ND	520000	ug/kg	8300
1,2-Dichlorobenzene	ND	1000000	ug/kg	14000
1,3-Dichlorobenzene	ND	1000000	ug/kg	6100
1,4-Dichlorobenzene	ND	1000000	ug/kg	6700
Dichlorodifluoromethane	ND	1000000	ug/kg	4500
1,1-Dichloroethane	ND	520000	ug/kg	6100
1,2-Dichloroethane	ND	520000	ug/kg	7800
cis-1,2-Dichloroethene	ND	260000	ug/kg	12000
trans-1,2-Dichloroethene	ND	260000	ug/kg	9300
1,1-Dichloroethene	ND	520000	ug/kg	7000
1,2-Dichloropropane	ND	520000	ug/kg	6200
cis-1,3-Dichloropropene	ND	520000	ug/kg	4600
trans-1,3-Dichloropropene	ND	520000	ug/kg	4500
Ethylbenzene	ND	520000	ug/kg	5700
2-Hexanone	ND	2100000	ug/kg	20000
Isopropylbenzene	ND	1000000	ug/kg	4300
Methyl acetate	ND	1000000	ug/kg	44000
Methylcyclohexane	ND	520000	ug/kg	7500
Methylene chloride	ND	520000	ug/kg	83000
4-Methyl-2-pentanone	ND	2100000	ug/kg	9300
Methyl tert-butyl ether	ND	2100000	ug/kg	8400
Naphthalene	28000000 B	1000000	ug/kg	8400

(Continued on next page)

Brown and Caldwell

Client Sample ID: MW-6 LNAPL

GC/MS Volatiles

Lot-Sample #...: A0K230408-009 Work Order #...: MAFPR1AA Matrix.....: LO

PARAMETER	RESULT	REPORTING		
		LIMIT	UNITS	MDL
Styrene	590000	520000	ug/kg	24000
1,1,2,2-Tetrachloroethane	ND	520000	ug/kg	6900
Tetrachloroethene	ND	520000	ug/kg	7600
Toluene	440000 J	520000	ug/kg	7700
1,2,4-Trichloro-benzene	ND	1000000	ug/kg	10000
1,1,1-Trichloroethane	ND	520000	ug/kg	8000
1,1,2-Trichloroethane	ND	520000	ug/kg	8300
Trichloroethene	ND	520000	ug/kg	10000
Trichlorofluoromethane	ND	1000000	ug/kg	7000
1,1,2-Trichloro-1,2,2-trifluoroethane	ND	2100000	ug/kg	8400
1,2,4-Trimethylbenzene	1000000	1000000	ug/kg	22000
1,3,5-Trimethylbenzene	820000 J	1000000	ug/kg	21000
Vinyl chloride	ND	1000000	ug/kg	13000
Xylenes (total)	430000 J	520000	ug/kg	13000
SURROGATE	PERCENT		RECOVERY	
	RECOVERY		LIMITS	
Dibromofluoromethane	0.0 DIL, *		(36 - 132)	
1,2-Dichloroethane-d4	0.0 DIL, *		(55 - 120)	
Toluene-d8	8.6 DIL, *		(29 - 132)	
4-Bromofluorobenzene	0.0 DIL, *		(27 - 136)	

NOTE(S):

DIL The concentration is estimated or not reported due to dilution or the presence of interfering analytes.

* Surrogate recovery is outside stated control limits.

B Method blank contamination. The associated method blank contains the target analyte at a reportable level.

J Estimated result. Result is less than RL.

Brown and Caldwell

MW-6 LNAPL

GC/MS Volatiles

Lot-Sample #: A0K230408-009

Work Order #: MAFPR1AA

Matrix: LO

MASS SPECTROMETER/DATA SYSTEM (MSDS) TENTATIVELY IDENTIFIED COMPOUNDS

<u>PARAMETER</u>	<u>CAS #</u>	<u>ESTIMATED RESULT</u>	<u>RETENTION TIME</u>	<u>UNITS</u>
Indene	95-13-6	1100000 NJM	10.752	ug/kg

NOTE(S):

M: Result was measured against nearest internal standard assuming a response factor of 1.

Brown and Caldwell

Client Sample ID: MW-6 DNAPL

GC/MS Semivolatiles

Lot-Sample #...: A0K230408-010 Work Order #...: MAFPV1AA Matrix.....: LO
 Date Sampled...: 11/16/10 16:10 Date Received...: 11/20/10
 Prep Date.....: 12/02/10 Analysis Date...: 12/14/10
 Prep Batch #...: 0336061
 Dilution Factor: 3681
 % Moisture.....: Method.....: SW846 8270C

PARAMETER	RESULT	REPORTING		
		LIMIT	UNITS	MDL
Acenaphthene	52000	25000	ug/kg	12000
Acenaphthylene	380000	25000	ug/kg	12000
Acetophenone	ND	370000	ug/kg	34000
Anthracene	310000	25000	ug/kg	12000
Atrazine	ND	740000	ug/kg	33000
Benzo(a)anthracene	ND	25000	ug/kg	12000
Benzo(a)pyrene	260000	25000	ug/kg	12000
Benzo(b)fluoranthene	200000	25000	ug/kg	12000
Benzo(ghi)perylene	150000	25000	ug/kg	12000
Benzo(k)fluoranthene	110000	25000	ug/kg	12000
Benzaldehyde	ND	370000	ug/kg	44000
1,1'-Biphenyl	130000 J	180000	ug/kg	99000
bis(2-Chloroethoxy) methane	ND	370000	ug/kg	81000
bis(2-Chloroethyl)- ether	ND	370000	ug/kg	7400
bis(2-Ethylhexyl) phthalate	ND	180000	ug/kg	70000
4-Bromophenyl phenyl ether	ND	180000	ug/kg	48000
Butyl benzyl phthalate	ND	180000	ug/kg	37000
Caprolactam	ND	1200000	ug/kg	140000
Carbazole	ND	180000	ug/kg	99000
4-Chloroaniline	ND	550000	ug/kg	63000
4-Chloro-3-methylphenol	ND	550000	ug/kg	77000
2-Chloronaphthalene	ND	180000	ug/kg	12000
2-Chlorophenol	ND	180000	ug/kg	99000
4-Chlorophenyl phenyl ether	ND	180000	ug/kg	48000
Chrysene	ND	25000	ug/kg	4000
Dibenz(a,h)anthracene	ND	25000	ug/kg	12000
Dibenzofuran	ND	180000	ug/kg	12000
3,3'-Dichlorobenzidine	ND	370000	ug/kg	66000
2,4-Dichlorophenol	ND	550000	ug/kg	74000
Diethyl phthalate	ND	180000	ug/kg	59000
2,4-Dimethylphenol	ND	550000	ug/kg	74000
Dimethyl phthalate	ND	180000	ug/kg	63000
Di-n-butyl phthalate	ND	180000	ug/kg	55000

(Continued on next page)

Brown and Caldwell

Client Sample ID: MW-6 DNAPL

GC/MS Semivolatiles

Lot-Sample #...: A0K230408-010

Work Order #...: MAFPV1AA

Matrix.....: LO

PARAMETER	RESULT	REPORTING		
		LIMIT	UNITS	MDL
4,6-Dinitro- 2-methylphenol	ND	550000	ug/kg	290000
2,4-Dinitrophenol	ND	1200000	ug/kg	290000
2,4-Dinitrotoluene	ND	740000	ug/kg	99000
2,6-Dinitrotoluene	ND	740000	ug/kg	77000
Di-n-octyl phthalate	ND	180000	ug/kg	99000
Fluoranthene	600000	25000	ug/kg	12000
Fluorene	280000	25000	ug/kg	12000
Hexachlorobenzene	ND	25000	ug/kg	7700
Hexachlorobutadiene	ND	180000	ug/kg	99000
Hexachlorocyclopenta- diene	ND	1200000	ug/kg	99000
Hexachloroethane	ND	180000	ug/kg	33000
Indeno(1,2,3-cd)pyrene	91000	25000	ug/kg	12000
Isophorone	ND	180000	ug/kg	48000
2-Methylnaphthalene	790000	25000	ug/kg	12000
2-Methylphenol	ND	740000	ug/kg	290000
4-Methylphenol	ND	740000	ug/kg	290000
Naphthalene	3400000	25000	ug/kg	12000
2-Nitroaniline	ND	740000	ug/kg	33000
3-Nitroaniline	ND	740000	ug/kg	59000
4-Nitroaniline	ND	740000	ug/kg	96000
Nitrobenzene	ND	370000	ug/kg	8100
2-Nitrophenol	ND	180000	ug/kg	99000
4-Nitrophenol	ND	1200000	ug/kg	290000
N-Nitrosodi-n-propyl- amine	ND	180000	ug/kg	99000
N-Nitrosodiphenylamine	ND	180000	ug/kg	77000
2,2'-oxybis (1-Chloropropane)	ND	370000	ug/kg	35000
Pentachlorophenol	ND	550000	ug/kg	290000
Phenanthrene	1200000	25000	ug/kg	12000
Phenol	ND	180000	ug/kg	99000
Pyrene	850000	25000	ug/kg	12000
2,4,5-Trichloro- phenol	ND	550000	ug/kg	92000
2,4,6-Trichloro- phenol	ND	550000	ug/kg	290000

(Continued on next page)

Brown and Caldwell

Client Sample ID: MW-6 DNAPL

GC/MS Semivolatiles

Lot-Sample #...: A0K230408-010 Work Order #...: MAFPV1AA Matrix.....: LO

<u>SURROGATE</u>	<u>PERCENT RECOVERY</u>	<u>RECOVERY LIMITS</u>
Nitrobenzene-d5	0.0 DIL, *	(24 - 112)
2-Fluorobiphenyl	0.0 DIL, *	(34 - 110)
Terphenyl-d14	0.0 DIL, *	(41 - 119)
Phenol-d5	0.0 DIL, *	(28 - 110)
2-Fluorophenol	0.0 DIL, *	(26 - 110)
2,4,6-Tribromophenol	0.0 DIL, *	(10 - 118)

NOTE(S):

DIL The concentration is estimated or not reported due to dilution or the presence of interfering analytes.

* Surrogate recovery is outside stated control limits.

J Estimated result. Result is less than RL.

Brown and Caldwell

MW-6 DNAPL

GC/MS Semivolatiles

Lot-Sample #: A0K230408-010

Work Order #: MAFPV1AA

Matrix: LO

MASS SPECTROMETER/DATA SYSTEM (MSDS) TENTATIVELY IDENTIFIED COMPOUNDS

PARAMETER	CAS #	ESTIMATED			RETENTION	
		RESULT			TIME	UNITS
Indene	95-13-6	180000	NJ	M	3.581	ug/kg
Unknown PAH		130000	J	M	7.0148	ug/kg
Unknown PAH		120000	J	M	7.0362	ug/kg
Unknown		360000	J	M	7.1004	ug/kg
Unknown		110000	J	M	7.9508	ug/kg
Unknown PAH		130000	J	M	9.8068	ug/kg

NOTE(S):

M: Result was measured against nearest internal standard assuming a response factor of 1.

Brown and Caldwell

Client Sample ID: GP-84, 15-16'

GC/MS Volatiles

Lot-Sample #...: A0K230408-011 Work Order #...: MAFPW1AD Matrix.....: SO
 Date Sampled...: 11/19/10 14:20 Date Received...: 11/20/10
 Prep Date.....: 11/30/10 Analysis Date...: 12/01/10
 Prep Batch #...: 0336449
 Dilution Factor: 49.02
 % Moisture.....: 21 Method.....: SW846 8260B

PARAMETER	RESULT	REPORTING		
		LIMIT	UNITS	MDL
Acetone	ND	62000	ug/kg	10000
Benzene	19000	15000	ug/kg	740
Bromodichloromethane	ND	15000	ug/kg	610
Bromoform	ND	15000	ug/kg	1200
Bromomethane	ND	15000	ug/kg	1800
2-Butanone	7900 J	62000	ug/kg	2700
Carbon disulfide	ND	15000	ug/kg	740
Carbon tetrachloride	ND	15000	ug/kg	390
Chlorobenzene	ND	15000	ug/kg	390
Dibromochloromethane	ND	15000	ug/kg	740
1,2-Dibromo-3-chloro- propane	ND	31000	ug/kg	3100
Chloroethane	ND	15000	ug/kg	3800
Chloroform	ND	15000	ug/kg	540
Chloromethane	ND	15000	ug/kg	860
Cyclohexane	ND	31000	ug/kg	2500
1,2-Dibromoethane	ND	15000	ug/kg	620
1,2-Dichlorobenzene	ND	15000	ug/kg	530
1,3-Dichlorobenzene	ND	15000	ug/kg	300
1,4-Dichlorobenzene	ND	15000	ug/kg	490
Dichlorodifluoromethane	ND	15000	ug/kg	990
1,1-Dichloroethane	1600 J	15000	ug/kg	1000
1,2-Dichloroethane	ND	15000	ug/kg	620
1,1-Dichloroethene	ND	15000	ug/kg	1100
cis-1,2-Dichloroethene	11000 J	15000	ug/kg	430
trans-1,2-Dichloroethene	ND	15000	ug/kg	570
1,2-Dichloropropane	ND	15000	ug/kg	510
cis-1,3-Dichloropropene	ND	15000	ug/kg	490
trans-1,3-Dichloropropene	ND	15000	ug/kg	1200
Ethylbenzene	29000	15000	ug/kg	330
Trichlorofluoromethane	ND	15000	ug/kg	990
2-Hexanone	ND	62000	ug/kg	1200
Isopropylbenzene	ND	15000	ug/kg	400
Methyl acetate	ND	31000	ug/kg	1500
Methylcyclohexane	ND	31000	ug/kg	740
Methylene chloride	ND	15000	ug/kg	4700
4-Methyl-2-pentanone	ND	62000	ug/kg	3000
Naphthalene	490000 B	15000	ug/kg	410

(Continued on next page)

Brown and Caldwell

Client Sample ID: GP-84, 15-16'

GC/MS Volatiles

Lot-Sample #...: A0K230408-011 Work Order #...: MAFPW1AD Matrix.....: SO

PARAMETER	RESULT	REPORTING		
		LIMIT	UNITS	MDL
Styrene	3600 J	15000	ug/kg	350
1,1,2,2-Tetrachloroethane	ND	15000	ug/kg	550
Tetrachloroethene	ND	15000	ug/kg	740
Toluene	120000	15000	ug/kg	1000
1,2,4-Trichloro-benzene	ND	15000	ug/kg	450
1,1,1-Trichloroethane	9900 J	15000	ug/kg	1300
1,1,2-Trichloroethane	ND	15000	ug/kg	740
Trichloroethene	740 J	15000	ug/kg	600
1,1,2-Trichloro-1,2,2-trifluoroethane	ND	15000	ug/kg	2400
1,2,4-Trimethylbenzene	14000 J	15000	ug/kg	310
1,3,5-Trimethylbenzene	5200 J	15000	ug/kg	360
Vinyl chloride	ND	15000	ug/kg	1100
Xylenes (total)	63000	31000	ug/kg	500
Methyl tert-butyl ether	ND	62000	ug/kg	440

SURROGATE	PERCENT		RECOVERY	
	RECOVERY		LIMITS	
Dibromofluoromethane	60	DIL	(30 - 122)	
1,2-Dichloroethane-d4	90	DIL	(39 - 128)	
Toluene-d8	79	DIL	(33 - 134)	
4-Bromofluorobenzene	96	DIL	(26 - 141)	

NOTE(S):

DIL The concentration is estimated or not reported due to dilution or the presence of interfering analytes.

Results and reporting limits have been adjusted for dry weight.

J Estimated result. Result is less than RL.

B Method blank contamination. The associated method blank contains the target analyte at a reportable level.

Brown and Caldwell

GP-84, 15-16'

GC/MS Volatiles

Lot-Sample #: A0K230408-011

Work Order #: MAFPW1AD

Matrix: SO

MASS SPECTROMETER/DATA SYSTEM (MSDS) TENTATIVELY IDENTIFIED COMPOUNDS

PARAMETER	CAS #	ESTIMATED		RETENTION		UNITS
		RESULT		TIME		
Indene	95-13-6	50000 NJ	M	11.675		ug/kg
Naphthalene, 1-methyl-	90-12-0	39000 NJ	M	14.148		ug/kg
Hexane		30000	Q	4.339		ug/kg
2-Methylnaphthalene		100000	Q	14.006		ug/kg

NOTE(S):

Q: Result was quantitated against the response factor of a calibration standard.

M: Result was measured against nearest internal standard assuming a response factor of 1.

Brown and Caldwell

Client Sample ID: GP-84, 15-16'

GC/MS Semivolatiles

Lot-Sample #...: A0K230408-011 Work Order #...: MAFPW1AC Matrix.....: SO
 Date Sampled...: 11/19/10 14:20 Date Received...: 11/20/10
 Prep Date.....: 12/01/10 Analysis Date...: 12/04/10
 Prep Batch #...: 0335034
 Dilution Factor: 125
 % Moisture.....: 21 Method.....: SW846 8270C

PARAMETER	RESULT	REPORTING		
		LIMIT	UNITS	MDL
Acenaphthene	7600	1000	ug/kg	520
Acenaphthylene	5200	1000	ug/kg	520
Acetophenone	ND	16000	ug/kg	1400
Anthracene	20000	1000	ug/kg	520
Atrazine	ND	31000	ug/kg	1400
Benzo(a)anthracene	13000	1000	ug/kg	520
Benzo(a)pyrene	12000	1000	ug/kg	520
Benzo(b)fluoranthene	8100	1000	ug/kg	520
Benzo(ghi)perylene	6800	1000	ug/kg	520
Benzo(k)fluoranthene	4500	1000	ug/kg	520
Benzaldehyde	ND	16000	ug/kg	1900
1,1'-Biphenyl	10000	7900	ug/kg	4200
bis(2-Chloroethoxy) methane	ND	16000	ug/kg	3500
bis(2-Chloroethyl)- ether	ND	16000	ug/kg	310
bis(2-Ethylhexyl) phthalate	ND	7900	ug/kg	3000
4-Bromophenyl phenyl ether	ND	7900	ug/kg	2000
Butyl benzyl phthalate	ND	7900	ug/kg	1600
Caprolactam	ND	52000	ug/kg	5800
Carbazole	ND	7900	ug/kg	4200
4-Chloroaniline	ND	24000	ug/kg	2700
4-Chloro-3-methylphenol	ND	24000	ug/kg	3300
2-Chloronaphthalene	ND	7900	ug/kg	520
2-Chlorophenol	ND	7900	ug/kg	4200
4-Chlorophenyl phenyl ether	ND	7900	ug/kg	2000
Chrysene	12000	1000	ug/kg	170
Dibenz(a,h)anthracene	ND	1000	ug/kg	520
Dibenzofuran	ND	7900	ug/kg	520
3,3'-Dichlorobenzidine	ND	16000	ug/kg	2800
2,4-Dichlorophenol	ND	24000	ug/kg	3100
Diethyl phthalate	ND	7900	ug/kg	2500
2,4-Dimethylphenol	ND	24000	ug/kg	3100
Dimethyl phthalate	ND	7900	ug/kg	2700
Di-n-butyl phthalate	ND	7900	ug/kg	2400

(Continued on next page)

Brown and Caldwell

Client Sample ID: GP-84, 15-16'

GC/MS Semivolatiles

Lot-Sample #...: A0K230408-011 Work Order #...: MAFPW1AC Matrix.....: SO

PARAMETER	RESULT	REPORTING		
		LIMIT	UNITS	MDL
4,6-Dinitro- 2-methylphenol	ND	24000	ug/kg	13000
2,4-Dinitrophenol	ND	52000	ug/kg	13000
2,4-Dinitrotoluene	ND	31000	ug/kg	4200
2,6-Dinitrotoluene	ND	31000	ug/kg	3300
Di-n-octyl phthalate	ND	7900	ug/kg	4200
Fluoranthene	29000	1000	ug/kg	520
Fluorene	15000	1000	ug/kg	520
Hexachlorobenzene	ND	1000	ug/kg	330
Hexachlorobutadiene	ND	7900	ug/kg	4200
Hexachlorocyclopenta- diene	ND	52000	ug/kg	4200
Hexachloroethane	ND	7900	ug/kg	1400
Indeno(1,2,3-cd)pyrene	4100	1000	ug/kg	520
Isophorone	ND	7900	ug/kg	2000
2-Methylnaphthalene	57000	1000	ug/kg	520
2-Methylphenol	ND	31000	ug/kg	13000
4-Methylphenol	ND	31000	ug/kg	13000
Naphthalene	250000	1000	ug/kg	520
2-Nitroaniline	ND	31000	ug/kg	1400
3-Nitroaniline	ND	31000	ug/kg	2500
4-Nitroaniline	ND	31000	ug/kg	4100
Nitrobenzene	ND	16000	ug/kg	350
2-Nitrophenol	ND	7900	ug/kg	4200
4-Nitrophenol	ND	52000	ug/kg	13000
N-Nitrosodi-n-propyl- amine	ND	7900	ug/kg	4200
N-Nitrosodiphenylamine	ND	7900	ug/kg	3300
2,2'-oxybis (1-Chloropropane)	ND	16000	ug/kg	1500
Pentachlorophenol	ND	24000	ug/kg	13000
Phenanthrene	72000	1000	ug/kg	520
Phenol	ND	7900	ug/kg	4200
Pyrene	47000	1000	ug/kg	520
2,4,5-Trichloro- phenol	ND	24000	ug/kg	3900
2,4,6-Trichloro- phenol	ND	24000	ug/kg	13000

(Continued on next page)

Brown and Caldwell

Client Sample ID: GP-84, 15-16'

GC/MS Semivolatiles

Lot-Sample #...: A0K230408-011 Work Order #...: MAFPW1AC Matrix.....: SO

<u>SURROGATE</u>	PERCENT <u>RECOVERY</u>	RECOVERY <u>LIMITS</u>
Nitrobenzene-d5	0.0 DIL, *	(24 - 112)
2-Fluorobiphenyl	0.0 DIL, *	(34 - 110)
Terphenyl-d14	0.0 DIL, *	(41 - 119)
Phenol-d5	0.0 DIL, *	(28 - 110)
2-Fluorophenol	0.0 DIL, *	(26 - 110)
2,4,6-Tribromophenol	0.0 DIL, *	(10 - 118)

NOTE(S):

DIL The concentration is estimated or not reported due to dilution or the presence of interfering analytes.

* Surrogate recovery is outside stated control limits.

Results and reporting limits have been adjusted for dry weight.

Brown and Caldwell

GP-84, 15-16'

GC/MS Semivolatiles

Lot-Sample #: A0K230408-011

Work Order #: MAFPW1AC

Matrix: SO

MASS SPECTROMETER/DATA SYSTEM (MSDS) TENTATIVELY IDENTIFIED COMPOUNDS

PARAMETER	CAS #	ESTIMATED		RETENTION	
		RESULT		TIME	UNITS
Unknown Aromatic		14000 J	M	2.7575	ug/kg
Unknown Aromatic		8900 J	M	2.9285	ug/kg
Unknown Aromatic		11000 J	M	3.6069	ug/kg
Indene	95-13-6	36000 NJ	M	3.9381	ug/kg
1H-Indene, 1-methyl-	767-59-9	4900 NJ	M	4.5097	ug/kg
Naphthalene, 1-methyl-	90-12-0	23000 NJ	M	5.3057	ug/kg
Unknown PAH		5800 J	M	5.6903	ug/kg
Unknown PAH		8600 J	M	5.7438	ug/kg
Dibenzothiophene	132-65-0	6800 NJ	M	7.0099	ug/kg
Unknown Hydrocarbon		5100 J	M	7.2449	ug/kg
Unknown PAH		10000 J	M	7.4426	ug/kg
Unknown PAH		11000 J	M	7.4639	ug/kg
Unknown PAH		24000 J	M	7.5334	ug/kg
Unknown		5900 J	M	7.6509	ug/kg
Unknown		5000 J	M	7.8806	ug/kg
Unknown PAH		6800 J	M	8.0355	ug/kg
Unknown PAH		6300 J	M	8.3668	ug/kg
Unknown PAH		5000 J	M	8.543	ug/kg
Unknown PAH		7200 J	M	10.209	ug/kg

NOTE(S):

M: Result was measured against nearest internal standard assuming a response factor of 1.

Brown and Caldwell

Client Sample ID: GP-84, 15-16'

GC Semivolatiles

Lot-Sample #...: A0K230408-011 Work Order #...: MAFPW1AE Matrix.....: SO
Date Sampled...: 11/19/10 14:20 Date Received..: 11/20/10
Prep Date.....: 12/02/10 Analysis Date..: 12/03/10
Prep Batch #...: 0336049
Dilution Factor: 1
% Moisture.....: 21 Method.....: SW846 8082

		REPORTING		
PARAMETER	RESULT	LIMIT	UNITS	MDL
Aroclor 1016	ND	42	ug/kg	26
Aroclor 1221	ND	42	ug/kg	20
Aroclor 1232	ND	42	ug/kg	18
Aroclor 1242	ND	42	ug/kg	16
Aroclor 1248	ND	42	ug/kg	21
Aroclor 1254	ND	42	ug/kg	21
Aroclor 1260	ND	42	ug/kg	21
	PERCENT	RECOVERY		
SURROGATE	RECOVERY	LIMITS		
Tetrachloro-m-xylene	105	(10 - 196)		
Decachlorobiphenyl	99	(10 - 199)		

NOTE(S):

Results and reporting limits have been adjusted for dry weight.

Brown and Caldwell

Client Sample ID: GP-84, 15-16'

General Chemistry

Lot-Sample #...: A0K230408-011 Work Order #...: MAFPW Matrix.....: SO
Date Sampled...: 11/19/10 14:20 Date Received..: 11/20/10
% Moisture.....: 21

<u>PARAMETER</u>	<u>RESULT</u>	<u>RL</u>	<u>UNITS</u>	<u>METHOD</u>	<u>PREPARATION- ANALYSIS DATE</u>	<u>PREP BATCH #</u>
Percent Solids	79.5	10.0	%	MCAWW 160.3 MOD	12/01-12/02/10	0335256
		Dilution Factor: 1		MDL.....: 10.0		

QUALITY CONTROL SECTION

METHOD BLANK REPORT

GC/MS Volatiles

Client Lot #...: A0K230408
MB Lot-Sample #: A0L020000-449

Work Order #...: MAR3T1AA

Matrix.....: SOLID

Prep Date.....: 11/30/10

Analysis Date..: 12/01/10

Prep Batch #...: 0336449

Dilution Factor: 1

PARAMETER	RESULT	REPORTING			METHOD
		LIMIT	UNITS		
Acetone	ND	1000	ug/kg	SW846	8260B
Benzene	ND	250	ug/kg	SW846	8260B
Bromodichloromethane	ND	250	ug/kg	SW846	8260B
Bromoform	ND	250	ug/kg	SW846	8260B
Bromomethane	ND	250	ug/kg	SW846	8260B
2-Butanone	ND	1000	ug/kg	SW846	8260B
Carbon disulfide	ND	250	ug/kg	SW846	8260B
Carbon tetrachloride	ND	250	ug/kg	SW846	8260B
Chlorobenzene	ND	250	ug/kg	SW846	8260B
Dibromochloromethane	ND	250	ug/kg	SW846	8260B
1,2-Dibromo-3-chloro-propane	ND	500	ug/kg	SW846	8260B
Chloroethane	ND	250	ug/kg	SW846	8260B
Chloroform	ND	250	ug/kg	SW846	8260B
Chloromethane	ND	250	ug/kg	SW846	8260B
Cyclohexane	ND	500	ug/kg	SW846	8260B
1,2-Dibromoethane	ND	250	ug/kg	SW846	8260B
1,2-Dichlorobenzene	ND	250	ug/kg	SW846	8260B
1,3-Dichlorobenzene	ND	250	ug/kg	SW846	8260B
1,4-Dichlorobenzene	8.3 J	250	ug/kg	SW846	8260B
Dichlorodifluoromethane	ND	250	ug/kg	SW846	8260B
1,1-Dichloroethane	ND	250	ug/kg	SW846	8260B
1,2-Dichloroethane	ND	250	ug/kg	SW846	8260B
1,1-Dichloroethene	ND	250	ug/kg	SW846	8260B
cis-1,2-Dichloroethene	ND	250	ug/kg	SW846	8260B
trans-1,2-Dichloroethene	ND	250	ug/kg	SW846	8260B
1,2-Dichloropropane	ND	250	ug/kg	SW846	8260B
cis-1,3-Dichloropropene	ND	250	ug/kg	SW846	8260B
trans-1,3-Dichloropropene	ND	250	ug/kg	SW846	8260B
Ethylbenzene	ND	250	ug/kg	SW846	8260B
Trichlorofluoromethane	ND	250	ug/kg	SW846	8260B
2-Hexanone	ND	1000	ug/kg	SW846	8260B
Isopropylbenzene	ND	250	ug/kg	SW846	8260B
Methyl acetate	ND	500	ug/kg	SW846	8260B
Methylcyclohexane	ND	500	ug/kg	SW846	8260B
Methylene chloride	ND	250	ug/kg	SW846	8260B
4-Methyl-2-pentanone	ND	1000	ug/kg	SW846	8260B
Naphthalene	11 J	250	ug/kg	SW846	8260B
Styrene	ND	250	ug/kg	SW846	8260B
1,1,2,2-Tetrachloroethane	ND	250	ug/kg	SW846	8260B
Tetrachloroethene	ND	250	ug/kg	SW846	8260B

(Continued on next page)

METHOD BLANK REPORT

GC/MS Volatiles

Client Lot #...: A0K230408

Work Order #...: MAR3T1AA

Matrix.....: SOLID

PARAMETER	RESULT	REPORTING		METHOD
		LIMIT	UNITS	
Toluene	ND	250	ug/kg	SW846 8260B
1,2,4-Trichloro-benzene	ND	250	ug/kg	SW846 8260B
1,1,1-Trichloroethane	ND	250	ug/kg	SW846 8260B
1,1,2-Trichloroethane	ND	250	ug/kg	SW846 8260B
Trichloroethene	ND	250	ug/kg	SW846 8260B
1,1,2-Trichloro-1,2,2-trifluoroethane	ND	250	ug/kg	SW846 8260B
1,2,4-Trimethylbenzene	ND	250	ug/kg	SW846 8260B
1,3,5-Trimethylbenzene	ND	250	ug/kg	SW846 8260B
Vinyl chloride	ND	250	ug/kg	SW846 8260B
Xylenes (total)	ND	500	ug/kg	SW846 8260B
Methyl tert-butyl ether	ND	1000	ug/kg	SW846 8260B

SURROGATE	PERCENT	RECOVERY
	RECOVERY	LIMITS
Dibromofluoromethane	77	(30 - 122)
1,2-Dichloroethane-d4	82	(39 - 128)
Toluene-d8	83	(33 - 134)
4-Bromofluorobenzene	75	(26 - 141)

NOTE(S):

Calculations are performed before rounding to avoid round-off errors in calculated results.

J Estimated result. Result is less than RL.

Brown and Caldwell

Method Blank Report

GC/MS Volatiles

Lot-Sample #: A0L020000-449 B Work Order #: MAR3T1AA Matrix: SOLID

MASS SPECTROMETER/DATA SYSTEM (MSDS) TENTATIVELY IDENTIFIED COMPOUNDS

<u>PARAMETER</u>	<u>CAS #</u>	<u>ESTIMATED RESULT</u>	<u>RETENTION TIME</u>	<u>UNITS</u>
Decane	124-18-5	360 NJ	M 10.67	ug/kg

NOTE(S):

M: Result was measured against nearest internal standard assuming a response factor of 1.

METHOD BLANK REPORT

GC/MS Volatiles

Client Lot #...: A0K230408
MB Lot-Sample #: A0L080000-315

Work Order #...: MA2JX1AA

Matrix.....: WASTE

Prep Date.....: 12/02/10

Analysis Date..: 12/07/10

Prep Batch #...: 0342315

Dilution Factor: 1

PARAMETER	RESULT	REPORTING			METHOD
		LIMIT	UNITS		
Acetone	ND	2500	ug/kg	SW846	8260B
Benzene	ND	620	ug/kg	SW846	8260B
Bromodichloromethane	ND	620	ug/kg	SW846	8260B
Bromoform	ND	620	ug/kg	SW846	8260B
Bromomethane	ND	1200	ug/kg	SW846	8260B
2-Butanone	ND	2500	ug/kg	SW846	8260B
Carbon disulfide	ND	620	ug/kg	SW846	8260B
Carbon tetrachloride	ND	620	ug/kg	SW846	8260B
Chlorobenzene	ND	620	ug/kg	SW846	8260B
Dibromochloromethane	ND	620	ug/kg	SW846	8260B
Chloroethane	ND	1200	ug/kg	SW846	8260B
Chloroform	ND	620	ug/kg	SW846	8260B
Chloromethane	ND	1200	ug/kg	SW846	8260B
Cyclohexane	ND	2500	ug/kg	SW846	8260B
1,2-Dibromo-3-chloro-propane	ND	1200	ug/kg	SW846	8260B
1,2-Dibromoethane	ND	620	ug/kg	SW846	8260B
1,2-Dichlorobenzene	ND	1200	ug/kg	SW846	8260B
1,3-Dichlorobenzene	ND	1200	ug/kg	SW846	8260B
1,4-Dichlorobenzene	ND	1200	ug/kg	SW846	8260B
Dichlorodifluoromethane	ND	1200	ug/kg	SW846	8260B
1,1-Dichloroethane	ND	620	ug/kg	SW846	8260B
1,2-Dichloroethane	ND	620	ug/kg	SW846	8260B
cis-1,2-Dichloroethene	ND	310	ug/kg	SW846	8260B
trans-1,2-Dichloroethene	ND	310	ug/kg	SW846	8260B
1,1-Dichloroethene	ND	620	ug/kg	SW846	8260B
1,2-Dichloropropane	ND	620	ug/kg	SW846	8260B
cis-1,3-Dichloropropene	ND	620	ug/kg	SW846	8260B
trans-1,3-Dichloropropene	ND	620	ug/kg	SW846	8260B
Ethylbenzene	ND	620	ug/kg	SW846	8260B
2-Hexanone	ND	2500	ug/kg	SW846	8260B
Isopropylbenzene	ND	1200	ug/kg	SW846	8260B
Methyl acetate	ND	1200	ug/kg	SW846	8260B
Methylcyclohexane	ND	620	ug/kg	SW846	8260B
Methylene chloride	ND	620	ug/kg	SW846	8260B
4-Methyl-2-pentanone	ND	2500	ug/kg	SW846	8260B
Methyl tert-butyl ether	ND	2500	ug/kg	SW846	8260B
Naphthalene	67 J	1200	ug/kg	SW846	8260B
Styrene	ND	620	ug/kg	SW846	8260B
1,1,2,2-Tetrachloroethane	ND	620	ug/kg	SW846	8260B
Tetrachloroethene	ND	620	ug/kg	SW846	8260B

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METHOD BLANK REPORT

GC/MS Volatiles

Client Lot #...: A0K230408

Work Order #...: MA2JX1AA

Matrix.....: WASTE

PARAMETER	RESULT	REPORTING		METHOD
		LIMIT	UNITS	
Toluene	ND	620	ug/kg	SW846 8260B
1,2,4-Trichloro-benzene	ND	1200	ug/kg	SW846 8260B
1,1,1-Trichloroethane	ND	620	ug/kg	SW846 8260B
1,1,2-Trichloroethane	ND	620	ug/kg	SW846 8260B
Trichloroethene	ND	620	ug/kg	SW846 8260B
Trichlorofluoromethane	ND	1200	ug/kg	SW846 8260B
1,1,2-Trichloro-1,2,2-trifluoroethane	ND	2500	ug/kg	SW846 8260B
1,2,4-Trimethylbenzene	ND	1200	ug/kg	SW846 8260B
1,3,5-Trimethylbenzene	ND	1200	ug/kg	SW846 8260B
Vinyl chloride	ND	1200	ug/kg	SW846 8260B
Xylenes (total)	ND	620	ug/kg	SW846 8260B

SURROGATE	PERCENT	RECOVERY
	RECOVERY	LIMITS
Dibromofluoromethane	85	(36 - 132)
1,2-Dichloroethane-d4	98	(55 - 120)
Toluene-d8	101	(29 - 132)
4-Bromofluorobenzene	98	(27 - 136)

NOTE(S):

Calculations are performed before rounding to avoid round-off errors in calculated results.

J Estimated result. Result is less than RL.

Brown and Caldwell

Method Blank Report

GC/MS Volatiles

Lot-Sample #: A0L080000-315 B Work Order #: MA2JX1AA Matrix: WASTE

MASS SPECTROMETER/DATA SYSTEM (MSDS) TENTATIVELY IDENTIFIED COMPOUNDS

<u>PARAMETER</u>	<u>CAS #</u>	<u>ESTIMATED RESULT</u>	<u>RETENTION TIME</u>	<u>UNITS</u>
None				ug/kg

METHOD BLANK REPORT

GC/MS Semivolatiles

Client Lot #...: A0K230408
MB Lot-Sample #: A0K250000-024

Work Order #...: MAKNC1AA

Matrix.....: WATER

Prep Date.....: 11/26/10

Analysis Date...: 12/02/10

Prep Batch #...: 0329024

Dilution Factor: 1

PARAMETER	RESULT	REPORTING			METHOD
		LIMIT	UNITS		
Acenaphthene	ND	0.20	ug/L	SW846	8270C
Acenaphthylene	ND	0.20	ug/L	SW846	8270C
Acetophenone	ND	1.0	ug/L	SW846	8270C
Anthracene	ND	0.20	ug/L	SW846	8270C
Atrazine	ND	1.0	ug/L	SW846	8270C
Benzo(a)anthracene	ND	0.20	ug/L	SW846	8270C
Benzo(a)pyrene	ND	0.20	ug/L	SW846	8270C
Benzo(b)fluoranthene	ND	0.20	ug/L	SW846	8270C
Benzo(ghi)perylene	ND	0.20	ug/L	SW846	8270C
Benzo(k)fluoranthene	ND	0.20	ug/L	SW846	8270C
Benzaldehyde	ND	1.0	ug/L	SW846	8270C
1,1'-Biphenyl	ND	1.0	ug/L	SW846	8270C
bis(2-Chloroethoxy) methane	ND	1.0	ug/L	SW846	8270C
bis(2-Chloroethyl)- ether	ND	1.0	ug/L	SW846	8270C
bis(2-Ethylhexyl) phthalate	ND	2.0	ug/L	SW846	8270C
4-Bromophenyl phenyl ether	ND	2.0	ug/L	SW846	8270C
Butyl benzyl phthalate	ND	1.0	ug/L	SW846	8270C
Caprolactam	ND	5.0	ug/L	SW846	8270C
Carbazole	ND	1.0	ug/L	SW846	8270C
4-Chloroaniline	ND	2.0	ug/L	SW846	8270C
4-Chloro-3-methylphenol	ND	2.0	ug/L	SW846	8270C
2-Chloronaphthalene	ND	1.0	ug/L	SW846	8270C
2-Chlorophenol	ND	1.0	ug/L	SW846	8270C
4-Chlorophenyl phenyl ether	ND	2.0	ug/L	SW846	8270C
Chrysene	ND	0.20	ug/L	SW846	8270C
Dibenz(a,h)anthracene	ND	0.20	ug/L	SW846	8270C
Dibenzofuran	ND	1.0	ug/L	SW846	8270C
3,3'-Dichlorobenzidine	ND	5.0	ug/L	SW846	8270C
2,4-Dichlorophenol	ND	2.0	ug/L	SW846	8270C
Diethyl phthalate	ND	1.0	ug/L	SW846	8270C
2,4-Dimethylphenol	ND	2.0	ug/L	SW846	8270C
Dimethyl phthalate	ND	1.0	ug/L	SW846	8270C
Di-n-butyl phthalate	ND	1.0	ug/L	SW846	8270C
4,6-Dinitro- 2-methylphenol	ND	5.0	ug/L	SW846	8270C
2,4-Dinitrophenol	ND	5.0	ug/L	SW846	8270C

(Continued on next page)

METHOD BLANK REPORT

GC/MS Semivolatiles

Client Lot #...: A0K230408

Work Order #...: MAKNC1AA

Matrix.....: WATER

PARAMETER	RESULT	REPORTING			METHOD
		LIMIT	UNITS		
2,4-Dinitrotoluene	ND	5.0	ug/L	SW846	8270C
2,6-Dinitrotoluene	ND	5.0	ug/L	SW846	8270C
Di-n-octyl phthalate	ND	1.0	ug/L	SW846	8270C
Fluoranthene	ND	0.20	ug/L	SW846	8270C
Fluorene	ND	0.20	ug/L	SW846	8270C
Hexachlorobenzene	ND	0.20	ug/L	SW846	8270C
Hexachlorobutadiene	ND	1.0	ug/L	SW846	8270C
Hexachlorocyclopenta- diene	ND	10	ug/L	SW846	8270C
Hexachloroethane	ND	1.0	ug/L	SW846	8270C
Indeno(1,2,3-cd)pyrene	ND	0.20	ug/L	SW846	8270C
Isophorone	ND	1.0	ug/L	SW846	8270C
2-Methylnaphthalene	ND	0.20	ug/L	SW846	8270C
2-Methylphenol	ND	1.0	ug/L	SW846	8270C
4-Methylphenol	ND	1.0	ug/L	SW846	8270C
Naphthalene	ND	0.20	ug/L	SW846	8270C
2-Nitroaniline	ND	2.0	ug/L	SW846	8270C
3-Nitroaniline	ND	2.0	ug/L	SW846	8270C
4-Nitroaniline	ND	2.0	ug/L	SW846	8270C
Nitrobenzene	ND	1.0	ug/L	SW846	8270C
2-Nitrophenol	ND	2.0	ug/L	SW846	8270C
4-Nitrophenol	ND	5.0	ug/L	SW846	8270C
N-Nitrosodi-n-propyl- amine	ND	1.0	ug/L	SW846	8270C
N-Nitrosodiphenylamine	ND	1.0	ug/L	SW846	8270C
2,2'-oxybis (1-Chloropropane)	ND	1.0	ug/L	SW846	8270C
Pentachlorophenol	ND	5.0	ug/L	SW846	8270C
Phenanthrene	ND	0.20	ug/L	SW846	8270C
Phenol	ND	1.0	ug/L	SW846	8270C
Pyrene	ND	0.20	ug/L	SW846	8270C
2,4,5-Trichloro- phenol	ND	5.0	ug/L	SW846	8270C
2,4,6-Trichloro- phenol	ND	5.0	ug/L	SW846	8270C

SURROGATE	PERCENT	RECOVERY
	RECOVERY	LIMITS
Nitrobenzene-d5	60	(27 - 111)
2-Fluorobiphenyl	56	(28 - 110)
Terphenyl-d14	90	(37 - 119)
Phenol-d5	58	(10 - 110)
2-Fluorophenol	57	(10 - 110)
2,4,6-Tribromophenol	52	(22 - 120)

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METHOD BLANK REPORT

GC/MS Semivolatiles

Client Lot #...: A0K230408

Work Order #...: MAKNC1AA

Matrix.....: WATER

NOTE(S):

Calculations are performed before rounding to avoid round-off errors in calculated results.

Brown and Caldwell

Method Blank Report

GC/MS Semivolatiles

Lot-Sample #: A0K250000-024 B Work Order #: MAKNC1AA Matrix: WATER

MASS SPECTROMETER/DATA SYSTEM (MSDS) TENTATIVELY IDENTIFIED COMPOUNDS

<u>PARAMETER</u>	<u>CAS #</u>	<u>ESTIMATED RESULT</u>	<u>RETENTION TIME</u>	<u>UNITS</u>
None				ug/L

METHOD BLANK REPORT

GC/MS Semivolatiles

Client Lot #...: A0K230408
MB Lot-Sample #: A0K290000-049

Work Order #...: MAK491AA

Matrix.....: SOLID

Prep Date.....: 11/29/10

Analysis Date...: 12/01/10

Prep Batch #...: 0333049

Dilution Factor: 1

PARAMETER	RESULT	REPORTING			METHOD
		LIMIT	UNITS		
Acenaphthene	ND	6.7	ug/kg	SW846	8270C
Acenaphthylene	ND	6.7	ug/kg	SW846	8270C
Acetophenone	ND	100	ug/kg	SW846	8270C
Anthracene	ND	6.7	ug/kg	SW846	8270C
Atrazine	ND	200	ug/kg	SW846	8270C
Benzo(a)anthracene	ND	6.7	ug/kg	SW846	8270C
Benzo(a)pyrene	ND	6.7	ug/kg	SW846	8270C
Benzo(b)fluoranthene	ND	6.7	ug/kg	SW846	8270C
Benzo(ghi)perylene	ND	6.7	ug/kg	SW846	8270C
Benzo(k)fluoranthene	ND	6.7	ug/kg	SW846	8270C
Benzaldehyde	ND	100	ug/kg	SW846	8270C
1,1'-Biphenyl	ND	50	ug/kg	SW846	8270C
bis(2-Chloroethoxy) methane	ND	100	ug/kg	SW846	8270C
bis(2-Chloroethyl)- ether	ND	100	ug/kg	SW846	8270C
bis(2-Ethylhexyl) phthalate	ND	50	ug/kg	SW846	8270C
4-Bromophenyl phenyl ether	ND	50	ug/kg	SW846	8270C
Butyl benzyl phthalate	ND	50	ug/kg	SW846	8270C
Caprolactam	ND	330	ug/kg	SW846	8270C
Carbazole	ND	50	ug/kg	SW846	8270C
4-Chloroaniline	ND	150	ug/kg	SW846	8270C
4-Chloro-3-methylphenol	ND	150	ug/kg	SW846	8270C
2-Chloronaphthalene	ND	50	ug/kg	SW846	8270C
2-Chlorophenol	ND	50	ug/kg	SW846	8270C
4-Chlorophenyl phenyl ether	ND	50	ug/kg	SW846	8270C
Chrysene	ND	6.7	ug/kg	SW846	8270C
Dibenz(a,h)anthracene	ND	6.7	ug/kg	SW846	8270C
Dibenzofuran	ND	50	ug/kg	SW846	8270C
3,3'-Dichlorobenzidine	ND	100	ug/kg	SW846	8270C
2,4-Dichlorophenol	ND	150	ug/kg	SW846	8270C
Diethyl phthalate	ND	50	ug/kg	SW846	8270C
2,4-Dimethylphenol	ND	150	ug/kg	SW846	8270C
Dimethyl phthalate	ND	50	ug/kg	SW846	8270C
Di-n-butyl phthalate	ND	50	ug/kg	SW846	8270C
4,6-Dinitro- 2-methylphenol	ND	150	ug/kg	SW846	8270C
2,4-Dinitrophenol	ND	330	ug/kg	SW846	8270C

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METHOD BLANK REPORT

GC/MS Semivolatiles

Client Lot #...: A0K230408

Work Order #...: MAK491AA

Matrix.....: SOLID

PARAMETER	RESULT	REPORTING			METHOD
		LIMIT	UNITS		
2,4-Dinitrotoluene	ND	200	ug/kg	SW846	8270C
2,6-Dinitrotoluene	ND	200	ug/kg	SW846	8270C
Di-n-octyl phthalate	ND	50	ug/kg	SW846	8270C
Fluoranthene	ND	6.7	ug/kg	SW846	8270C
Fluorene	ND	6.7	ug/kg	SW846	8270C
Hexachlorobenzene	ND	6.7	ug/kg	SW846	8270C
Hexachlorobutadiene	ND	50	ug/kg	SW846	8270C
Hexachlorocyclopenta- diene	ND	330	ug/kg	SW846	8270C
Hexachloroethane	ND	50	ug/kg	SW846	8270C
Indeno(1,2,3-cd)pyrene	ND	6.7	ug/kg	SW846	8270C
Isophorone	ND	50	ug/kg	SW846	8270C
2-Methylnaphthalene	ND	6.7	ug/kg	SW846	8270C
2-Methylphenol	ND	200	ug/kg	SW846	8270C
4-Methylphenol	ND	200	ug/kg	SW846	8270C
Naphthalene	19	6.7	ug/kg	SW846	8270C
2-Nitroaniline	ND	200	ug/kg	SW846	8270C
3-Nitroaniline	ND	200	ug/kg	SW846	8270C
4-Nitroaniline	ND	200	ug/kg	SW846	8270C
Nitrobenzene	ND	100	ug/kg	SW846	8270C
2-Nitrophenol	ND	50	ug/kg	SW846	8270C
4-Nitrophenol	ND	330	ug/kg	SW846	8270C
N-Nitrosodi-n-propyl- amine	ND	50	ug/kg	SW846	8270C
N-Nitrosodiphenylamine	ND	50	ug/kg	SW846	8270C
2,2'-oxybis (1-Chloropropane)	ND	100	ug/kg	SW846	8270C
Pentachlorophenol	ND	150	ug/kg	SW846	8270C
Phenanthrene	ND	6.7	ug/kg	SW846	8270C
Phenol	ND	50	ug/kg	SW846	8270C
Pyrene	ND	6.7	ug/kg	SW846	8270C
2,4,5-Trichloro- phenol	ND	150	ug/kg	SW846	8270C
2,4,6-Trichloro- phenol	ND	150	ug/kg	SW846	8270C

SURROGATE	PERCENT	RECOVERY
	RECOVERY	LIMITS
Nitrobenzene-d5	60	(24 - 112)
2-Fluorobiphenyl	56	(34 - 110)
Terphenyl-d14	82	(41 - 119)
Phenol-d5	56	(28 - 110)
2-Fluorophenol	61	(26 - 110)
2,4,6-Tribromophenol	31	(10 - 118)

(Continued on next page)

METHOD BLANK REPORT

GC/MS Semivolatiles

Client Lot #...: A0K230408

Work Order #...: MAK491AA

Matrix.....: SOLID

NOTE(S):

Calculations are performed before rounding to avoid round-off errors in calculated results.

Brown and Caldwell

Method Blank Report

GC/MS Semivolatiles

Lot-Sample #: A0K290000-049 B Work Order #: MAK491AA Matrix: SOLID

MASS SPECTROMETER/DATA SYSTEM (MSDS) TENTATIVELY IDENTIFIED COMPOUNDS

<u>PARAMETER</u>	<u>CAS #</u>	<u>ESTIMATED RESULT</u>	<u>RETENTION TIME</u>	<u>UNITS</u>
Unknown Aldol Condensate		10000 JA M	2.554	ug/kg
Unknown		47 J M	7.207	ug/kg

NOTE(S):

M: Result was measured against nearest internal standard assuming a response factor of 1.

METHOD BLANK REPORT

GC/MS Semivolatiles

Client Lot #...: A0K230408
MB Lot-Sample #: A0L010000-034

Work Order #...: MANJX1AA

Matrix.....: SOLID

Analysis Date...: 12/03/10

Prep Date.....: 12/01/10

Prep Batch #...: 0335034

Dilution Factor: 1

PARAMETER	RESULT	REPORTING			METHOD
		LIMIT	UNITS		
Acenaphthene	ND	6.7	ug/kg	SW846	8270C
Acenaphthylene	ND	6.7	ug/kg	SW846	8270C
Acetophenone	ND	100	ug/kg	SW846	8270C
Anthracene	ND	6.7	ug/kg	SW846	8270C
Atrazine	ND	200	ug/kg	SW846	8270C
Benzo(a)anthracene	ND	6.7	ug/kg	SW846	8270C
Benzo(a)pyrene	ND	6.7	ug/kg	SW846	8270C
Benzo(b)fluoranthene	ND	6.7	ug/kg	SW846	8270C
Benzo(ghi)perylene	ND	6.7	ug/kg	SW846	8270C
Benzo(k)fluoranthene	ND	6.7	ug/kg	SW846	8270C
Benzaldehyde	ND	100	ug/kg	SW846	8270C
1,1'-Biphenyl	ND	50	ug/kg	SW846	8270C
bis(2-Chloroethoxy) methane	ND	100	ug/kg	SW846	8270C
bis(2-Chloroethyl)- ether	ND	100	ug/kg	SW846	8270C
bis(2-Ethylhexyl) phthalate	ND	50	ug/kg	SW846	8270C
4-Bromophenyl phenyl ether	ND	50	ug/kg	SW846	8270C
Butyl benzyl phthalate	ND	50	ug/kg	SW846	8270C
Caprolactam	ND	330	ug/kg	SW846	8270C
Carbazole	ND	50	ug/kg	SW846	8270C
4-Chloroaniline	ND	150	ug/kg	SW846	8270C
4-Chloro-3-methylphenol	ND	150	ug/kg	SW846	8270C
2-Chloronaphthalene	ND	50	ug/kg	SW846	8270C
2-Chlorophenol	ND	50	ug/kg	SW846	8270C
4-Chlorophenyl phenyl ether	ND	50	ug/kg	SW846	8270C
Chrysene	ND	6.7	ug/kg	SW846	8270C
Dibenz(a,h)anthracene	ND	6.7	ug/kg	SW846	8270C
Dibenzofuran	ND	50	ug/kg	SW846	8270C
3,3'-Dichlorobenzidine	ND	100	ug/kg	SW846	8270C
2,4-Dichlorophenol	ND	150	ug/kg	SW846	8270C
Diethyl phthalate	ND	50	ug/kg	SW846	8270C
2,4-Dimethylphenol	ND	150	ug/kg	SW846	8270C
Dimethyl phthalate	ND	50	ug/kg	SW846	8270C
Di-n-butyl phthalate	ND	50	ug/kg	SW846	8270C
4,6-Dinitro- 2-methylphenol	ND	150	ug/kg	SW846	8270C
2,4-Dinitrophenol	ND	330	ug/kg	SW846	8270C

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METHOD BLANK REPORT

GC/MS Semivolatiles

Client Lot #...: A0K230408

Work Order #...: MANJX1AA

Matrix.....: SOLID

PARAMETER	RESULT	REPORTING			METHOD
		LIMIT	UNITS		
2,4-Dinitrotoluene	ND	200	ug/kg	SW846	8270C
2,6-Dinitrotoluene	ND	200	ug/kg	SW846	8270C
Di-n-octyl phthalate	ND	50	ug/kg	SW846	8270C
Fluoranthene	ND	6.7	ug/kg	SW846	8270C
Fluorene	ND	6.7	ug/kg	SW846	8270C
Hexachlorobenzene	ND	6.7	ug/kg	SW846	8270C
Hexachlorobutadiene	ND	50	ug/kg	SW846	8270C
Hexachlorocyclopenta- diene	ND	330	ug/kg	SW846	8270C
Hexachloroethane	ND	50	ug/kg	SW846	8270C
Indeno(1,2,3-cd)pyrene	ND	6.7	ug/kg	SW846	8270C
Isophorone	ND	50	ug/kg	SW846	8270C
2-Methylnaphthalene	ND	6.7	ug/kg	SW846	8270C
2-Methylphenol	ND	200	ug/kg	SW846	8270C
4-Methylphenol	ND	200	ug/kg	SW846	8270C
Naphthalene	ND	6.7	ug/kg	SW846	8270C
2-Nitroaniline	ND	200	ug/kg	SW846	8270C
3-Nitroaniline	ND	200	ug/kg	SW846	8270C
4-Nitroaniline	ND	200	ug/kg	SW846	8270C
Nitrobenzene	ND	100	ug/kg	SW846	8270C
2-Nitrophenol	ND	50	ug/kg	SW846	8270C
4-Nitrophenol	ND	330	ug/kg	SW846	8270C
N-Nitrosodi-n-propyl- amine	ND	50	ug/kg	SW846	8270C
N-Nitrosodiphenylamine	ND	50	ug/kg	SW846	8270C
2,2'-oxybis (1-Chloropropane)	ND	100	ug/kg	SW846	8270C
Pentachlorophenol	ND	150	ug/kg	SW846	8270C
Phenanthrene	ND	6.7	ug/kg	SW846	8270C
Phenol	ND	50	ug/kg	SW846	8270C
Pyrene	ND	6.7	ug/kg	SW846	8270C
2,4,5-Trichloro- phenol	ND	150	ug/kg	SW846	8270C
2,4,6-Trichloro- phenol	ND	150	ug/kg	SW846	8270C

SURROGATE	PERCENT	RECOVERY
	RECOVERY	LIMITS
Nitrobenzene-d5	63	(24 - 112)
2-Fluorobiphenyl	66	(34 - 110)
Terphenyl-d14	85	(41 - 119)
Phenol-d5	67	(28 - 110)
2-Fluorophenol	67	(26 - 110)
2,4,6-Tribromophenol	51	(10 - 118)

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METHOD BLANK REPORT

GC/MS Semivolatiles

Client Lot #...: A0K230408

Work Order #...: MANJX1AA

Matrix.....: SOLID

NOTE(S):

Calculations are performed before rounding to avoid round-off errors in calculated results.

Brown and Caldwell

Method Blank Report

GC/MS Semivolatiles

Lot-Sample #: A0L010000-034 B Work Order #: MANJX1AA Matrix: SOLID

MASS SPECTROMETER/DATA SYSTEM (MSDS) TENTATIVELY IDENTIFIED COMPOUNDS

<u>PARAMETER</u>	<u>CAS #</u>	<u>ESTIMATED</u>		<u>RETENTION</u>		<u>UNITS</u>
		<u>RESULT</u>		<u>TIME</u>		
Unknown Aldol Condensate		6400 JA	M	2.526		ug/kg
Unknown		31 J	M	5.064		ug/kg
Unknown		50 J	M	5.742		ug/kg
Unknown		61 J	M	9.712		ug/kg

NOTE(S):

M: Result was measured against nearest internal standard assuming a response factor of 1.

METHOD BLANK REPORT

GC/MS Semivolatiles

Client Lot #...: A0K230408
 MB Lot-Sample #: A0L020000-061

Work Order #...: MAQAW1AA

Matrix.....: SOLID

Analysis Date...: 12/08/10

Prep Date.....: 12/02/10

Dilution Factor: 1

Prep Batch #...: 0336061

PARAMETER	RESULT	REPORTING		
		LIMIT	UNITS	METHOD
Acenaphthene	ND	6.7	ug/kg	SW846 8270C
Acenaphthylene	ND	6.7	ug/kg	SW846 8270C
Acetophenone	ND	100	ug/kg	SW846 8270C
Anthracene	ND	6.7	ug/kg	SW846 8270C
Atrazine	ND	200	ug/kg	SW846 8270C
Benzo(a)anthracene	ND	6.7	ug/kg	SW846 8270C
Benzo(a)pyrene	ND	6.7	ug/kg	SW846 8270C
Benzo(b)fluoranthene	ND	6.7	ug/kg	SW846 8270C
Benzo(ghi)perylene	ND	6.7	ug/kg	SW846 8270C
Benzo(k)fluoranthene	ND	6.7	ug/kg	SW846 8270C
Benzaldehyde	ND	100	ug/kg	SW846 8270C
1,1'-Biphenyl	ND	50	ug/kg	SW846 8270C
bis(2-Chloroethoxy) methane	ND	100	ug/kg	SW846 8270C
bis(2-Chloroethyl)- ether	ND	100	ug/kg	SW846 8270C
bis(2-Ethylhexyl) phthalate	29 J	50	ug/kg	SW846 8270C
4-Bromophenyl phenyl ether	ND	50	ug/kg	SW846 8270C
Butyl benzyl phthalate	ND	50	ug/kg	SW846 8270C
Caprolactam	ND	330	ug/kg	SW846 8270C
Carbazole	ND	50	ug/kg	SW846 8270C
4-Chloroaniline	ND	150	ug/kg	SW846 8270C
4-Chloro-3-methylphenol	ND	150	ug/kg	SW846 8270C
2-Chloronaphthalene	ND	50	ug/kg	SW846 8270C
2-Chlorophenol	ND	50	ug/kg	SW846 8270C
4-Chlorophenyl phenyl ether	ND	50	ug/kg	SW846 8270C
Chrysene	ND	6.7	ug/kg	SW846 8270C
Dibenz(a,h)anthracene	ND	6.7	ug/kg	SW846 8270C
Dibenzofuran	ND	50	ug/kg	SW846 8270C
3,3'-Dichlorobenzidine	ND	100	ug/kg	SW846 8270C
2,4-Dichlorophenol	ND	150	ug/kg	SW846 8270C
Diethyl phthalate	ND	50	ug/kg	SW846 8270C
2,4-Dimethylphenol	ND	150	ug/kg	SW846 8270C
Dimethyl phthalate	ND	50	ug/kg	SW846 8270C
Di-n-butyl phthalate	ND	50	ug/kg	SW846 8270C
4,6-Dinitro- 2-methylphenol	ND	150	ug/kg	SW846 8270C
2,4-Dinitrophenol	ND	330	ug/kg	SW846 8270C

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METHOD BLANK REPORT

GC/MS Semivolatiles

Client Lot #...: A0K230408

Work Order #...: MAQAW1AA

Matrix.....: SOLID

PARAMETER	RESULT	REPORTING			METHOD
		LIMIT	UNITS		
2,4-Dinitrotoluene	ND	200	ug/kg	SW846	8270C
2,6-Dinitrotoluene	ND	200	ug/kg	SW846	8270C
Di-n-octyl phthalate	ND	50	ug/kg	SW846	8270C
Fluoranthene	ND	6.7	ug/kg	SW846	8270C
Fluorene	ND	6.7	ug/kg	SW846	8270C
Hexachlorobenzene	ND	6.7	ug/kg	SW846	8270C
Hexachlorobutadiene	ND	50	ug/kg	SW846	8270C
Hexachlorocyclopenta- diene	ND	330	ug/kg	SW846	8270C
Hexachloroethane	ND	50	ug/kg	SW846	8270C
Indeno(1,2,3-cd)pyrene	ND	6.7	ug/kg	SW846	8270C
Isophorone	ND	50	ug/kg	SW846	8270C
2-Methylnaphthalene	ND	6.7	ug/kg	SW846	8270C
2-Methylphenol	ND	200	ug/kg	SW846	8270C
4-Methylphenol	ND	200	ug/kg	SW846	8270C
Naphthalene	ND	6.7	ug/kg	SW846	8270C
2-Nitroaniline	ND	200	ug/kg	SW846	8270C
3-Nitroaniline	ND	200	ug/kg	SW846	8270C
4-Nitroaniline	ND	200	ug/kg	SW846	8270C
Nitrobenzene	ND	100	ug/kg	SW846	8270C
2-Nitrophenol	ND	50	ug/kg	SW846	8270C
4-Nitrophenol	ND	330	ug/kg	SW846	8270C
N-Nitrosodi-n-propyl- amine	ND	50	ug/kg	SW846	8270C
N-Nitrosodiphenylamine	ND	50	ug/kg	SW846	8270C
2,2'-oxybis (1-Chloropropane)	ND	100	ug/kg	SW846	8270C
Pentachlorophenol	ND	150	ug/kg	SW846	8270C
Phenanthrene	ND	6.7	ug/kg	SW846	8270C
Phenol	ND	50	ug/kg	SW846	8270C
Pyrene	ND	6.7	ug/kg	SW846	8270C
2,4,5-Trichloro- phenol	ND	150	ug/kg	SW846	8270C
2,4,6-Trichloro- phenol	ND	150	ug/kg	SW846	8270C

SURROGATE	PERCENT	RECOVERY
	RECOVERY	LIMITS
Nitrobenzene-d5	59	(24 - 112)
2-Fluorobiphenyl	56	(34 - 110)
Terphenyl-d14	74	(41 - 119)
Phenol-d5	60	(28 - 110)
2-Fluorophenol	65	(26 - 110)
2,4,6-Tribromophenol	63	(10 - 118)

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METHOD BLANK REPORT

GC/MS Semivolatiles

Client Lot #...: A0K230408

Work Order #...: MAQAW1AA

Matrix.....: SOLID

NOTE(S):

Calculations are performed before rounding to avoid round-off errors in calculated results.

J Estimated result. Result is less than RL.

Brown and Caldwell

Method Blank Report

GC/MS Semivolatiles

Lot-Sample #: A0L020000-061 B Work Order #: MAQAW1AA Matrix: SOLID

MASS SPECTROMETER/DATA SYSTEM (MSDS) TENTATIVELY IDENTIFIED COMPOUNDS

<u>PARAMETER</u>	<u>CAS #</u>	<u>ESTIMATED RESULT</u>	<u>RETENTION TIME</u>	<u>UNITS</u>
Unknown Aldol Condensate		5100 JA M	2.48	ug/kg
Unknown Organic Acid		34 J M	7.107	ug/kg
Unknown		130 J M	7.631	ug/kg

NOTE(S):

M: Result was measured against nearest internal standard assuming a response factor of 1.

METHOD BLANK REPORT

GC Semivolatiles

Client Lot #...: A0K230408 Work Order #...: MAP981AA Matrix.....: WATER
 MB Lot-Sample #: A0L020000-047
 Prep Date.....: 12/02/10
 Analysis Date...: 12/02/10 Prep Batch #...: 0336047
 Dilution Factor: 1

<u>PARAMETER</u>	<u>RESULT</u>	<u>REPORTING</u>		
		<u>LIMIT</u>	<u>UNITS</u>	<u>METHOD</u>
Aroclor 1016	ND	1.0	ug/L	SW846 8082
Aroclor 1221	ND	1.0	ug/L	SW846 8082
Aroclor 1232	ND	1.0	ug/L	SW846 8082
Aroclor 1242	ND	1.0	ug/L	SW846 8082
Aroclor 1248	ND	1.0	ug/L	SW846 8082
Aroclor 1254	ND	1.0	ug/L	SW846 8082
Aroclor 1260	ND	1.0	ug/L	SW846 8082
		<u>PERCENT</u>	<u>RECOVERY</u>	
<u>SURROGATE</u>	<u>RECOVERY</u>		<u>LIMITS</u>	
Tetrachloro-m-xylene	78		(27 - 130)	
Decachlorobiphenyl	27		(10 - 127)	

NOTE(S):

Calculations are performed before rounding to avoid round-off errors in calculated results.

METHOD BLANK REPORT

GC Semivolatiles

Client Lot #...: A0K230408
MB Lot-Sample #: A0L020000-049

Work Order #...: MAQAC1AA

Matrix.....: SOLID

Analysis Date...: 12/03/10

Prep Date.....: 12/02/10

Prep Batch #...: 0336049

Dilution Factor: 1

PARAMETER	RESULT	REPORTING		
		LIMIT	UNITS	METHOD
Aroclor 1016	ND	33	ug/kg	SW846 8082
Aroclor 1221	ND	33	ug/kg	SW846 8082
Aroclor 1232	ND	33	ug/kg	SW846 8082
Aroclor 1242	ND	33	ug/kg	SW846 8082
Aroclor 1248	ND	33	ug/kg	SW846 8082
Aroclor 1254	ND	33	ug/kg	SW846 8082
Aroclor 1260	ND	33	ug/kg	SW846 8082

SURROGATE	PERCENT	RECOVERY
	RECOVERY	LIMITS
Tetrachloro-m-xylene	66	(10 - 196)
Decachlorobiphenyl	60	(10 - 199)

NOTE(S):

Calculations are performed before rounding to avoid round-off errors in calculated results.

METHOD BLANK REPORT

General Chemistry

Client Lot #...: A0K230408

Matrix.....: WATER

<u>PARAMETER</u>	<u>RESULT</u>	<u>REPORTING</u> <u>LIMIT</u>	<u>UNITS</u>	<u>METHOD</u>	<u>PREPARATION-</u> <u>ANALYSIS DATE</u>	<u>PREP</u> <u>BATCH #</u>
Cyanide, Total	ND	Work Order #: MANV61AA		MB Lot-Sample #:	A0L010000-134	
		0.010	mg/L	SW846 9012A	12/01/10	0335134
		Dilution Factor: 1				

NOTE(S):

Calculations are performed before rounding to avoid round-off errors in calculated results.

METHOD BLANK REPORT

General Chemistry

Client Lot #...: A0K230408

Matrix.....: SOLID

<u>PARAMETER</u>	<u>RESULT</u>	<u>REPORTING</u> <u>LIMIT</u>	<u>UNITS</u>	<u>METHOD</u>	<u>PREPARATION-</u> <u>ANALYSIS DATE</u>	<u>PREP</u> <u>BATCH #</u>
Percent Solids		Work Order #:	MAPGX1AA	MB Lot-Sample #:	A0L010000-256	
	ND	10.0	%	MCAWW 160.3 MOD	12/01-12/02/10	0335256
		Dilution Factor:	1			

NOTE(S):

Calculations are performed before rounding to avoid round-off errors in calculated results.

LABORATORY CONTROL SAMPLE EVALUATION REPORT

GC/MS Volatiles

Client Lot #...: A0K230408 Work Order #...: MAR3T1AC-LCS Matrix.....: SOLID
 LCS Lot-Sample#: A0L020000-449 MAR3T1AD-LCSD
 Prep Date.....: 11/30/10 Analysis Date...: 12/01/10
 Prep Batch #...: 0336449
 Dilution Factor: 1

PARAMETER	PERCENT RECOVERY	RECOVERY LIMITS	RPD	RPD LIMITS	METHOD
Benzene	93	(70 - 117)			SW846 8260B
	93	(70 - 117)	0.11	(0-20)	SW846 8260B
Chlorobenzene	95	(71 - 116)			SW846 8260B
	96	(71 - 116)	1.0	(0-30)	SW846 8260B
1,1-Dichloroethene	103	(44 - 143)			SW846 8260B
	93	(44 - 143)	10	(0-30)	SW846 8260B
Toluene	94	(66 - 123)			SW846 8260B
	92	(66 - 123)	2.6	(0-30)	SW846 8260B
Trichloroethene	101	(59 - 124)			SW846 8260B
	104	(59 - 124)	3.0	(0-30)	SW846 8260B

SURROGATE	PERCENT RECOVERY	RECOVERY LIMITS
Dibromofluoromethane	88	(30 - 122)
	87	(30 - 122)
1,2-Dichloroethane-d4	83	(39 - 128)
	83	(39 - 128)
Toluene-d8	85	(33 - 134)
	83	(33 - 134)
4-Bromofluorobenzene	78	(26 - 141)
	87	(26 - 141)

NOTE(S):

Calculations are performed before rounding to avoid round-off errors in calculated results.
 Bold print denotes control parameters

LABORATORY CONTROL SAMPLE EVALUATION REPORT

GC/MS Volatiles

Client Lot #...: A0K230408 Work Order #...: MA2JX1AC-LCS Matrix.....: WASTE
 LCS Lot-Sample#: A0L080000-315 MA2JX1AD-LCSD
 Prep Date.....: 12/02/10 Analysis Date...: 12/07/10
 Prep Batch #...: 0342315
 Dilution Factor: 1

PARAMETER	PERCENT RECOVERY	RECOVERY LIMITS	RPD	RPD LIMITS	METHOD
Benzene	91	(72 - 122)			SW846 8260B
	98	(72 - 122)	7.0	(0-20)	SW846 8260B
Chlorobenzene	87	(74 - 121)			SW846 8260B
	99	(74 - 121)	12	(0-30)	SW846 8260B
1,1-Dichloroethene	95	(44 - 150)			SW846 8260B
	93	(44 - 150)	1.4	(0-30)	SW846 8260B
Toluene	97	(70 - 124)			SW846 8260B
	105	(70 - 124)	7.4	(0-30)	SW846 8260B
Trichloroethene	86	(63 - 131)			SW846 8260B
	97	(63 - 131)	12	(0-30)	SW846 8260B

SURROGATE	PERCENT RECOVERY	RECOVERY LIMITS
Dibromofluoromethane	80	(36 - 132)
	78	(36 - 132)
1,2-Dichloroethane-d4	91	(55 - 120)
	91	(55 - 120)
Toluene-d8	90	(29 - 132)
	91	(29 - 132)
4-Bromofluorobenzene	90	(27 - 136)
	90	(27 - 136)

NOTE(S):

Calculations are performed before rounding to avoid round-off errors in calculated results.
 Bold print denotes control parameters

LABORATORY CONTROL SAMPLE EVALUATION REPORT

GC/MS Semivolatiles

Client Lot #...: A0K230408 Work Order #...: MAKNC1AC-LCS Matrix.....: WATER
 LCS Lot-Sample#: A0K250000-024 MAKNC1AD-LCSD
 Prep Date.....: 11/26/10 Analysis Date...: 12/02/10
 Prep Batch #...: 0329024
 Dilution Factor: 1

PARAMETER	PERCENT RECOVERY	RECOVERY LIMITS	RPD	RPD LIMITS	METHOD
Acenaphthene	69	(40 - 110)			SW846 8270C
	59	(40 - 110)	16	(0-30)	SW846 8270C
1,2,4-Trichloro- benzene	57	(25 - 110)			SW846 8270C
	42	(25 - 110)	30	(0-30)	SW846 8270C
1,4-Dichlorobenzene	61	(19 - 110)			SW846 8270C
	42 p	(19 - 110)	38	(0-30)	SW846 8270C
4-Chloro-3-methylphenol	70	(39 - 110)			SW846 8270C
	59	(39 - 110)	16	(0-30)	SW846 8270C
2-Chlorophenol	76	(27 - 110)			SW846 8270C
	55 p	(27 - 110)	32	(0-30)	SW846 8270C
2,4-Dinitrotoluene	81	(52 - 123)			SW846 8270C
	78	(52 - 123)	4.8	(0-30)	SW846 8270C
4-Nitrophenol	68	(12 - 130)			SW846 8270C
	68	(12 - 130)	0.30	(0-30)	SW846 8270C
N-Nitrosodi-n-propyl- amine	79	(37 - 121)			SW846 8270C
	60	(37 - 121)	28	(0-30)	SW846 8270C
Pentachlorophenol	55	(26 - 110)			SW846 8270C
	51	(26 - 110)	8.0	(0-30)	SW846 8270C
Phenol	75	(14 - 112)			SW846 8270C
	56	(14 - 112)	29	(0-30)	SW846 8270C
Pyrene	74	(55 - 120)			SW846 8270C
	73	(55 - 120)	0.70	(0-30)	SW846 8270C

SURROGATE	PERCENT RECOVERY	RECOVERY LIMITS
Nitrobenzene-d5	70	(27 - 111)
	57	(27 - 111)
2-Fluorobiphenyl	66	(28 - 110)
	56	(28 - 110)
Terphenyl-d14	84	(37 - 119)
	84	(37 - 119)
Phenol-d5	72	(10 - 110)
	54	(10 - 110)
2-Fluorophenol	72	(10 - 110)
	54	(10 - 110)
2,4,6-Tribromophenol	66	(22 - 120)

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LABORATORY CONTROL SAMPLE EVALUATION REPORT

GC/MS Semivolatiles

Client Lot #...: A0K230408 Work Order #...: MAKNC1AC-LCS Matrix.....: WATER
LCS Lot-Sample#: A0K250000-024 MAKNC1AD-LCSD

<u>SURROGATE</u>	<u>PERCENT</u> <u>RECOVERY</u>	<u>RECOVERY</u> <u>LIMITS</u>
	66	(22 - 120)

NOTE(S) :

Calculations are performed before rounding to avoid round-off errors in calculated results.

Bold print denotes control parameters

p Relative percent difference (RPD) is outside stated control limits.

LABORATORY CONTROL SAMPLE EVALUATION REPORT

GC/MS Semivolatiles

Client Lot #...: A0K230408 Work Order #...: MAK491AC Matrix.....: SOLID
 LCS Lot-Sample#: A0K290000-049
 Prep Date.....: 11/29/10 Analysis Date...: 12/01/10
 Prep Batch #...: 0333049
 Dilution Factor: 1

PARAMETER	PERCENT RECOVERY	RECOVERY LIMITS	METHOD
Acenaphthene	67	(46 - 110)	SW846 8270C
1,2,4-Trichloro- benzene	69	(43 - 110)	SW846 8270C
1,4-Dichlorobenzene	71	(38 - 110)	SW846 8270C
4-Chloro-3-methylphenol	66	(42 - 110)	SW846 8270C
2-Chlorophenol	69	(39 - 110)	SW846 8270C
2,4-Dinitrotoluene	74	(55 - 116)	SW846 8270C
4-Nitrophenol	53	(24 - 117)	SW846 8270C
N-Nitrosodi-n-propyl- amine	72	(40 - 114)	SW846 8270C
Pentachlorophenol	41	(10 - 110)	SW846 8270C
Phenol	68	(39 - 110)	SW846 8270C
Pyrene	76	(58 - 113)	SW846 8270C

SURROGATE	PERCENT RECOVERY	RECOVERY LIMITS
Nitrobenzene-d5	66	(24 - 112)
2-Fluorobiphenyl	64	(34 - 110)
Terphenyl-d14	83	(41 - 119)
Phenol-d5	65	(28 - 110)
2-Fluorophenol	67	(26 - 110)
2,4,6-Tribromophenol	62	(10 - 118)

NOTE(S):

Calculations are performed before rounding to avoid round-off errors in calculated results.

Bold print denotes control parameters

LABORATORY CONTROL SAMPLE EVALUATION REPORT

GC/MS Semivolatiles

Client Lot #...: A0K230408 Work Order #...: MANJX1AC Matrix.....: SOLID
 LCS Lot-Sample#: A0L010000-034
 Prep Date.....: 12/01/10 Analysis Date...: 12/03/10
 Prep Batch #...: 0335034
 Dilution Factor: 1

<u>PARAMETER</u>	PERCENT <u>RECOVERY</u>	RECOVERY <u>LIMITS</u>	<u>METHOD</u>
Acenaphthene	67	(46 - 110)	SW846 8270C
1,2,4-Trichloro- benzene	67	(43 - 110)	SW846 8270C
1,4-Dichlorobenzene	71	(38 - 110)	SW846 8270C
4-Chloro-3-methylphenol	70	(42 - 110)	SW846 8270C
2-Chlorophenol	70	(39 - 110)	SW846 8270C
2,4-Dinitrotoluene	77	(55 - 116)	SW846 8270C
4-Nitrophenol	71	(24 - 117)	SW846 8270C
N-Nitrosodi-n-propyl- amine	69	(40 - 114)	SW846 8270C
Pentachlorophenol	50	(10 - 110)	SW846 8270C
Phenol	71	(39 - 110)	SW846 8270C
Pyrene	74	(58 - 113)	SW846 8270C

<u>SURROGATE</u>	PERCENT <u>RECOVERY</u>	RECOVERY <u>LIMITS</u>
Nitrobenzene-d5	70	(24 - 112)
2-Fluorobiphenyl	68	(34 - 110)
Terphenyl-d14	85	(41 - 119)
Phenol-d5	72	(28 - 110)
2-Fluorophenol	73	(26 - 110)
2,4,6-Tribromophenol	65	(10 - 118)

NOTE(S):

Calculations are performed before rounding to avoid round-off errors in calculated results.

Bold print denotes control parameters

LABORATORY CONTROL SAMPLE EVALUATION REPORT

GC/MS Semivolatiles

Client Lot #...: A0K230408 Work Order #...: MAQAW1AC-LCS Matrix.....: SOLID
 LCS Lot-Sample#: A0L020000-061 MAQAW1AD-LCSD
 Prep Date.....: 12/02/10 Analysis Date...: 12/08/10
 Prep Batch #...: 0336061
 Dilution Factor: 1

PARAMETER	PERCENT RECOVERY	RECOVERY LIMITS	RPD	RPD LIMITS	METHOD
Acenaphthene	61	(46 - 110)			SW846 8270C
	60	(46 - 110)	1.6	(0-30)	SW846 8270C
1,2,4-Trichloro- benzene	60	(43 - 110)			SW846 8270C
	61	(43 - 110)	0.60	(0-30)	SW846 8270C
1,4-Dichlorobenzene	62	(38 - 110)			SW846 8270C
	64	(38 - 110)	3.3	(0-30)	SW846 8270C
4-Chloro-3-methylphenol	61	(42 - 110)			SW846 8270C
	64	(42 - 110)	3.8	(0-30)	SW846 8270C
2-Chlorophenol	60	(39 - 110)			SW846 8270C
	64	(39 - 110)	5.5	(0-30)	SW846 8270C
2,4-Dinitrotoluene	69	(55 - 116)			SW846 8270C
	67	(55 - 116)	2.8	(0-30)	SW846 8270C
4-Nitrophenol	59	(24 - 117)			SW846 8270C
	46	(24 - 117)	25	(0-30)	SW846 8270C
N-Nitrosodi-n-propyl- amine	63	(40 - 114)			SW846 8270C
	66	(40 - 114)	5.7	(0-30)	SW846 8270C
Pentachlorophenol	67	(10 - 110)			SW846 8270C
	66	(10 - 110)	1.9	(0-30)	SW846 8270C
Phenol	61	(39 - 110)			SW846 8270C
	64	(39 - 110)	4.6	(0-30)	SW846 8270C
Pyrene	64	(58 - 113)			SW846 8270C
	62	(58 - 113)	3.2	(0-30)	SW846 8270C

SURROGATE	PERCENT RECOVERY	RECOVERY LIMITS
Nitrobenzene-d5	63	(24 - 112)
	63	(24 - 112)
2-Fluorobiphenyl	61	(34 - 110)
	60	(34 - 110)
Terphenyl-d14	75	(41 - 119)
	72	(41 - 119)
Phenol-d5	62	(28 - 110)
	66	(28 - 110)
2-Fluorophenol	65	(26 - 110)
	69	(26 - 110)
2,4,6-Tribromophenol	68	(10 - 118)

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LABORATORY CONTROL SAMPLE EVALUATION REPORT

GC/MS Semivolatiles

Client Lot #...: A0K230408 Work Order #...: MAQAW1AC-LCS Matrix.....: SOLID
LCS Lot-Sample#: A0L020000-061 MAQAW1AD-LCSD

	PERCENT	RECOVERY
<u>SURROGATE</u>	<u>RECOVERY</u>	<u>LIMITS</u>
	62	(10 - 118)

NOTE(S):

Calculations are performed before rounding to avoid round-off errors in calculated results.

Bold print denotes control parameters

LABORATORY CONTROL SAMPLE EVALUATION REPORT

GC Semivolatiles

Client Lot #...: A0K230408 Work Order #...: MAP981AC-LCS Matrix.....: WATER
 LCS Lot-Sample#: A0L020000-047 MAP981AD-LCSD
 Prep Date.....: 12/02/10 Analysis Date...: 12/02/10
 Prep Batch #...: 0336047
 Dilution Factor: 2

<u>PARAMETER</u>	<u>PERCENT RECOVERY</u>	<u>RECOVERY LIMITS</u>	<u>RPD</u>	<u>RPD LIMITS</u>	<u>METHOD</u>
Aroclor 1016	97	(44 - 119)			SW846 8082
	61 p	(44 - 119)	45	(0-30)	SW846 8082
Aroclor 1260	81	(41 - 118)			SW846 8082
	58 p	(41 - 118)	33	(0-30)	SW846 8082

<u>SURROGATE</u>	<u>PERCENT RECOVERY</u>	<u>RECOVERY LIMITS</u>
Tetrachloro-m-xylene	92	(27 - 130)
	56	(27 - 130)
Decachlorobiphenyl	44	(10 - 127)
	40	(10 - 127)

NOTE(S):

Calculations are performed before rounding to avoid round-off errors in calculated results.

Bold print denotes control parameters

p Relative percent difference (RPD) is outside stated control limits.

LABORATORY CONTROL SAMPLE EVALUATION REPORT

GC Semivolatiles

Client Lot #...: A0K230408 Work Order #...: MAQAC1AC Matrix.....: SOLID
 LCS Lot-Sample#: A0L020000-049
 Prep Date.....: 12/02/10 Analysis Date...: 12/03/10
 Prep Batch #...: 0336049
 Dilution Factor: 1

<u>PARAMETER</u>	<u>PERCENT RECOVERY</u>	<u>RECOVERY LIMITS</u>	<u>METHOD</u>
Aroclor 1016	96	(34 - 127)	SW846 8082
Aroclor 1260	84	(32 - 141)	SW846 8082

<u>SURROGATE</u>	<u>PERCENT RECOVERY</u>	<u>RECOVERY LIMITS</u>
Tetrachloro-m-xylene	122	(10 - 196)
Decachlorobiphenyl	94	(10 - 199)

NOTE(S):

Calculations are performed before rounding to avoid round-off errors in calculated results.

Bold print denotes control parameters

LABORATORY CONTROL SAMPLE EVALUATION REPORT

General Chemistry

Client Lot #...: A0K230408

Matrix.....: WATER

<u>PARAMETER</u>	<u>PERCENT RECOVERY</u>	<u>RECOVERY LIMITS</u>	<u>METHOD</u>	<u>PREPARATION- ANALYSIS DATE</u>	<u>PREP BATCH #</u>
Cyanide, Total	69	(69 - 118)	Work Order #: MANV61AC SW846 9012A Dilution Factor: 1	LCS Lot-Sample#: A0L010000-134 12/01/10	0335134

NOTE(S):

Calculations are performed before rounding to avoid round-off errors in calculated results.

MATRIX SPIKE SAMPLE EVALUATION REPORT

GC/MS Semivolatiles

Client Lot #...: A0K230408 Work Order #...: MAFPA1AD-MS Matrix.....: SO
 MS Lot-Sample #: A0K230408-002 MAFPA1AE-MSD
 Date Sampled...: 11/18/10 15:00 Date Received...: 11/20/10
 Prep Date.....: 11/29/10 Analysis Date...: 12/04/10
 Prep Batch #...: 0333049
 Dilution Factor: 80

PARAMETER	PERCENT RECOVERY	RECOVERY LIMITS	RPD	RPD LIMITS	METHOD
Acenaphthene	288 DIL,a	(10 - 200)			SW846 8270C
	62 DIL,p	(10 - 200)	74	(0-30)	SW846 8270C
1,2,4-Trichloro- benzene	92 DIL	(33 - 110)			SW846 8270C
	93 DIL	(33 - 110)	1.1	(0-30)	SW846 8270C
1,4-Dichlorobenzene	93 DIL	(26 - 110)			SW846 8270C
	82 DIL	(26 - 110)	13	(0-30)	SW846 8270C
4-Chloro-3-methylphenol	0.0 DIL,a	(32 - 117)			SW846 8270C
	0.0 DIL,a	(32 - 117)	0.0	(0-30)	SW846 8270C
2-Chlorophenol	0.0 DIL,a	(32 - 110)			SW846 8270C
	0.0 DIL,a	(32 - 110)	0.0	(0-30)	SW846 8270C
2,4-Dinitrotoluene	117 DIL	(42 - 118)			SW846 8270C
	91 DIL	(42 - 118)	24	(0-30)	SW846 8270C
4-Nitrophenol	0.0 DIL,a	(10 - 125)			SW846 8270C
	0.0 DIL,a	(10 - 125)	0.0	(0-30)	SW846 8270C
N-Nitrosodi-n-propyl- amine	0.0 DIL,a	(30 - 121)			SW846 8270C
	0.0 DIL,a	(30 - 121)	0.0	(0-30)	SW846 8270C
Pentachlorophenol	0.0 DIL,a	(10 - 182)			SW846 8270C
	0.0 DIL,a	(10 - 182)	0.0	(0-30)	SW846 8270C
Phenol	125 DIL	(10 - 144)			SW846 8270C
	117 DIL	(10 - 144)	7.2	(0-30)	SW846 8270C
Pyrene	3940	(10 - 200)			SW846 8270C
	Qualifiers: DIL,a				
	202	(10 - 200)	124	(0-30)	SW846 8270C
	Qualifiers: DIL,a,p				

SURROGATE	PERCENT RECOVERY	RECOVERY LIMITS
Nitrobenzene-d5	0.0	(24 - 112)
	Qualifiers: DIL,*	
	0.0	(24 - 112)
	Qualifiers: DIL,*	
2-Fluorobiphenyl	0.0	(34 - 110)
	Qualifiers: DIL,*	
	0.0	(34 - 110)
	Qualifiers: DIL,*	

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MATRIX SPIKE SAMPLE EVALUATION REPORT

GC/MS Semivolatiles

Client Lot #...: A0K230408 Work Order #...: MAFPA1AD-MS Matrix.....: SO
MS Lot-Sample #: A0K230408-002 MAFPA1AE-MSD

<u>SURROGATE</u>	<u>PERCENT RECOVERY</u>	<u>RECOVERY LIMITS</u>
Terphenyl-d14	0.0 Qualifiers: DIL,*	(41 - 119)
	0.0 Qualifiers: DIL,*	(41 - 119)
Phenol-d5	60 DIL 0.0	(28 - 110) (28 - 110)
	Qualifiers: DIL,*	
2-Fluorophenol	72 DIL	(26 - 110)
	65 DIL	(26 - 110)
2,4,6-Tribromophenol	0.0	(10 - 118)
	Qualifiers: DIL,*	
	0.0	(10 - 118)
	Qualifiers: DIL,*	

NOTE(S):

Calculations are performed before rounding to avoid round-off errors in calculated results.

Bold print denotes control parameters

DIL The concentration is estimated or not reported due to dilution or the presence of interfering analytes.

p Relative percent difference (RPD) is outside stated control limits.

Results and reporting limits have been adjusted for dry weight.

* Surrogate recovery is outside stated control limits.

a Spiked analyte recovery is outside stated control limits.

MATRIX SPIKE SAMPLE EVALUATION REPORT

GC/MS Semivolatiles

Client Lot #...: A0K230408 Work Order #...: MAGF31D3-MS Matrix.....: SOLID
 MS Lot-Sample #: A0K230478-026 MAGF31D4-MSD
 Date Sampled...: 11/20/10 15:55 Date Received...: 11/23/10
 Prep Date.....: 12/01/10 Analysis Date...: 12/06/10
 Prep Batch #...: 0335034
 Dilution Factor: 1 % Moisture.....: 19

PARAMETER	PERCENT RECOVERY	RECOVERY LIMITS	RPD	RPD LIMITS	METHOD
Acenaphthene	0.0 a	(10 - 200)			SW846 8270C
	0.0 a	(10 - 200)	0.0	(0-30)	SW846 8270C
1,2,4-Trichloro- benzene	0.0 a	(33 - 110)			SW846 8270C
	0.0 a	(33 - 110)	0.0	(0-30)	SW846 8270C
1,4-Dichlorobenzene	0.0 a	(26 - 110)			SW846 8270C
	0.0 a	(26 - 110)	0.0	(0-30)	SW846 8270C
4-Chloro-3-methylphenol	0.0 a	(32 - 117)			SW846 8270C
	0.0 a	(32 - 117)	0.0	(0-30)	SW846 8270C
2-Chlorophenol	0.0 a	(32 - 110)			SW846 8270C
	0.0 a	(32 - 110)	0.0	(0-30)	SW846 8270C
2,4-Dinitrotoluene	0.0 a	(42 - 118)			SW846 8270C
	0.0 a	(42 - 118)	0.0	(0-30)	SW846 8270C
4-Nitrophenol	0.0 a	(10 - 125)			SW846 8270C
	0.0 a	(10 - 125)	0.0	(0-30)	SW846 8270C
N-Nitrosodi-n-propyl- amine	0.0 a	(30 - 121)			SW846 8270C
	0.0 a	(30 - 121)	0.0	(0-30)	SW846 8270C
Pentachlorophenol	0.0 a	(10 - 182)			SW846 8270C
	0.0 a	(10 - 182)	0.0	(0-30)	SW846 8270C
Phenol	0.0 a	(10 - 144)			SW846 8270C
	0.0 a	(10 - 144)	0.0	(0-30)	SW846 8270C
Pyrene	0.048 a	(10 - 200)			SW846 8270C
	0.0 a	(10 - 200)	0.0	(0-30)	SW846 8270C

SURROGATE	PERCENT RECOVERY	RECOVERY LIMITS
Nitrobenzene-d5	60	(24 - 112)
	57	(24 - 112)
2-Fluorobiphenyl	61	(34 - 110)
	58	(34 - 110)
Terphenyl-d14	94	(41 - 119)
	89	(41 - 119)
Phenol-d5	63	(28 - 110)
	59	(28 - 110)
2-Fluorophenol	68	(26 - 110)
	63	(26 - 110)

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MATRIX SPIKE SAMPLE EVALUATION REPORT

GC/MS Semivolatiles

Client Lot #...: A0K230408 Work Order #...: MAGF31D3-MS Matrix.....: SOLID
MS Lot-Sample #: A0K230478-026 MAGF31D4-MSD

<u>SURROGATE</u>	<u>PERCENT RECOVERY</u>	<u>RECOVERY LIMITS</u>
2,4,6-Tribromophenol	50	(10 - 118)
	35	(10 - 118)

NOTE(S):

Calculations are performed before rounding to avoid round-off errors in calculated results.

Bold print denotes control parameters

a Spiked analyte recovery is outside stated control limits.

Results and reporting limits have been adjusted for dry weight.

MATRIX SPIKE SAMPLE EVALUATION REPORT

GC/MS Semivolatiles

Client Lot #...: A0K230408 Work Order #...: MAM731AW-MS Matrix.....: SOLID
 MS Lot-Sample #: A0K300498-001 MAM731AX-MSD
 Date Sampled...: 11/29/10 10:30 Date Received...: 11/30/10
 Prep Date.....: 12/01/10 Analysis Date...: 12/07/10
 Prep Batch #...: 0335034
 Dilution Factor: 1 % Moisture.....: 10

PARAMETER	PERCENT RECOVERY	RECOVERY LIMITS	RPD	RPD LIMITS	METHOD
Acenaphthene	61	(10 - 200)			SW846 8270C
	64	(10 - 200)	5.0	(0-30)	SW846 8270C
1,2,4-Trichloro- benzene	60	(33 - 110)			SW846 8270C
	63	(33 - 110)	3.5	(0-30)	SW846 8270C
1,4-Dichlorobenzene	58	(26 - 110)			SW846 8270C
	63	(26 - 110)	8.3	(0-30)	SW846 8270C
4-Chloro-3-methylphenol	66	(32 - 117)			SW846 8270C
	68	(32 - 117)	2.9	(0-30)	SW846 8270C
2-Chlorophenol	61	(32 - 110)			SW846 8270C
	63	(32 - 110)	3.1	(0-30)	SW846 8270C
2,4-Dinitrotoluene	74	(42 - 118)			SW846 8270C
	73	(42 - 118)	1.0	(0-30)	SW846 8270C
4-Nitrophenol	44	(10 - 125)			SW846 8270C
	38	(10 - 125)	14	(0-30)	SW846 8270C
N-Nitrosodi-n-propyl- amine	59	(30 - 121)			SW846 8270C
	63	(30 - 121)	5.6	(0-30)	SW846 8270C
Pentachlorophenol	50	(10 - 182)			SW846 8270C
	41	(10 - 182)	20	(0-30)	SW846 8270C
Phenol	59	(10 - 144)			SW846 8270C
	60	(10 - 144)	3.3	(0-30)	SW846 8270C
Pyrene	67	(10 - 200)			SW846 8270C
	67	(10 - 200)	0.74	(0-30)	SW846 8270C

SURROGATE	PERCENT RECOVERY	RECOVERY LIMITS
Nitrobenzene-d5	56	(24 - 112)
	60	(24 - 112)
2-Fluorobiphenyl	60	(34 - 110)
	65	(34 - 110)
Terphenyl-d14	82	(41 - 119)
	79	(41 - 119)
Phenol-d5	60	(28 - 110)
	61	(28 - 110)
2-Fluorophenol	64	(26 - 110)
	65	(26 - 110)

(Continued on next page)

MATRIX SPIKE SAMPLE EVALUATION REPORT

GC/MS Semivolatiles

Client Lot #...: A0K230408 Work Order #...: MAM731AW-MS Matrix.....: SOLID
MS Lot-Sample #: A0K300498-001 MAM731AX-MSD

<u>SURROGATE</u>	<u>PERCENT RECOVERY</u>	<u>RECOVERY LIMITS</u>
2,4,6-Tribromophenol	54	(10 - 118)
	51	(10 - 118)

NOTE(S):

Calculations are performed before rounding to avoid round-off errors in calculated results.

Bold print denotes control parameters

Results and reporting limits have been adjusted for dry weight.

MATRIX SPIKE SAMPLE EVALUATION REPORT

GC Semivolatiles

Client Lot #...: A0K230408 Work Order #...: MAPVE1AD-MS Matrix.....: SOLID
 MS Lot-Sample #: A0L010584-001 MAPVE1AE-MSD
 Date Sampled...: 11/18/10 12:10 Date Received...: 11/20/10
 Prep Date.....: 12/02/10 Analysis Date...: 12/03/10
 Prep Batch #...: 0336049
 Dilution Factor: 5000 % Moisture.....: 8.5

PARAMETER	PERCENT RECOVERY	RECOVERY LIMITS	RPD	RPD LIMITS	METHOD
Aroclor 1016	13600	(10 - 199)			SW846 8082
	Qualifiers: DIL,a				
	80500	(10 - 199)	52	(0-30)	SW846 8082
	Qualifiers: DIL,a,p				
Aroclor 1260	0.0 DIL,a	(10 - 199)			SW846 8082
	0.0 DIL,a	(10 - 199)	0.0	(0-30)	SW846 8082
SURROGATE	PERCENT RECOVERY	RECOVERY LIMITS			
Tetrachloro-m-xylene	0.0	(10 - 196)			
	Qualifiers: DIL,*				
	0.0	(10 - 196)			
	Qualifiers: DIL,*				
Decachlorobiphenyl	1150	(10 - 199)			
	Qualifiers: DIL,*				
	1330	(10 - 199)			
	Qualifiers: DIL,*				

NOTE(S):

Calculations are performed before rounding to avoid round-off errors in calculated results.

Bold print denotes control parameters

DIL The concentration is estimated or not reported due to dilution or the presence of interfering analytes.

a Spiked analyte recovery is outside stated control limits.

p Relative percent difference (RPD) is outside stated control limits.

Results and reporting limits have been adjusted for dry weight.

* Surrogate recovery is outside stated control limits.

MATRIX SPIKE SAMPLE EVALUATION REPORT

General Chemistry

Client Lot #...: A0K230408

Matrix.....: WATER

Date Sampled...: 11/23/10 10:22 Date Received...: 11/24/10

PARAMETER	PERCENT RECOVERY	RPD	PREPARATION-	PREP
RECOVERY LIMITS	RPD LIMITS	METHOD	ANALYSIS DATE	BATCH #
Total Cyanide	WO#: MAHRQ1AF-MS/MAHRQ1AG-MSD	MS Lot-Sample #: A0K240402-003		
88	(42 - 140)	SW846 9012A	12/01/10	0335134
98	(42 - 140) 10 (0-20)	SW846 9012A	12/01/10	0335134
Dilution Factor: 1				

NOTE(S):

Calculations are performed before rounding to avoid round-off errors in calculated results.

SAMPLE DUPLICATE EVALUATION REPORT

General Chemistry

Client Lot #...: A0K230408

Work Order #...: MADXD-SMP
MADXD-DUP

Matrix.....: SOLID

Date Sampled...: 11/19/10

Date Received...: 11/20/10

% Moisture.....: 17

PARAM	RESULT	DUPLICATE RESULT	UNITS	RPD	RPD LIMIT	METHOD	PREPARATION- ANALYSIS DATE	PREP BATCH #
Percent Solids	83.3	82.9	%	0.42	(0-20)	SD Lot-Sample #: A0K220405-012 MCAWW 160.3 MOD	12/01-12/02/10	0335256

Dilution Factor: 1

SAMPLE DUPLICATE EVALUATION REPORT

General Chemistry

Client Lot #...: A0K230408

Work Order #...: MAE2N-SMP
MAE2N-DUP

Matrix.....: SOLID

Date Sampled...: 11/17/10 10:25 Date Received...: 11/19/10

% Moisture.....: 34

PARAM	RESULT	DUPLICATE RESULT	UNITS	RPD	RPD LIMIT	METHOD	PREPARATION- ANALYSIS DATE	PREP BATCH #
Percent Solids	66.3	66.8	%	0.72	(0-20)	SD Lot-Sample #: A0K220488-002 MCAWW 160.3 MOD	12/01-12/02/10	0335256

Dilution Factor: 1

TestAmerica

TestAmerica Laboratory location: _____

Regulatory program: ☐ DW ☐ NPDES ☐ RCRA ☐ Other _____

TAL-0018 (1008)

TestAmerica Cooler Receipt Form/Narrative

Lot Number: AOK230408

North Canton Facility

Client Brown + Caldwell Project CRS Elyria By: [Signature]Cooler Received on 11/20/10 Opened on 11-22-10 (Signature)FedEx ☒ UPS ☐ DHL ☐ FAS ☐ Stetson ☐ Client Drop Off ☐ TestAmerica Courier ☐ Other ☐TestAmerica Cooler # _____ Multiple Coolers ☒ Foam Box ☐ Client Cooler ☐ Other ☐1. Were custody seals on the outside of the cooler(s)? Yes ☐ No ☒ Intact? Yes ☐ No ☐ NA ☒

If YES, Quantity _____ Quantity Unsalvageable _____

Were custody seals on the outside of cooler(s) signed and dated? Yes ☐ No ☐ NA ☒Were custody seals on the bottle(s)? Yes ☐ No ☒

If YES, are there any exceptions? _____

2. Shippers' packing slip attached to the cooler(s)? Yes ☒ No ☐3. Did custody papers accompany the sample(s)? Yes ☒ No ☐Relinquished by client? Yes ☐ No ☐4. Were the custody papers signed in the appropriate place? Yes ☒ No ☐5. Packing material used: Bubble Wrap ☒ Foam ☐ None ☐ Other _____6. Cooler temperature upon receipt _____ °C See back of form for multiple coolers/temps ☒METHOD: IR ☒ Other ☐COOLANT: Wet Ice ☒ Blue Ice ☐ Dry Ice ☐ Water ☐ None ☐7. Did all bottles arrive in good condition (Unbroken)? Yes ☒ No ☐8. Could all bottle labels be reconciled with the COC? Yes ☒ No ☐9. Were sample(s) at the correct pH upon receipt? Yes ☒ No ☐ NA ☒ WB10. Were correct bottle(s) used for the test(s) indicated? Yes ☒ No ☐11. Were air bubbles >6 mm in any VOA vials? Yes ☐ No ☐ NA ☒12. Sufficient quantity received to perform indicated analyses? Yes ☒ No ☐13. Was a trip blank present in the cooler(s)? Yes ☐ No ☒ Were VOAs on the COC? Yes ☐ No ☒Contacted PM AMD Date 11/22/10 by gmc via Verbal ☒ Voice Mail ☐ Other ☐Concerning #14

14. CHAIN OF CUSTODY

The following discrepancies occurred:

COC HAS TRIP BLANK on it BUT NO sample received. Will not log.

Sample MW-6 did not receive VOC vials. Will not log.

Received Sample MW-6 does not have cyanide marked in COC but we received volume - will log CN per client/AMD

Sample Y(2)-1516 ^{7.72/10} received 1x100 for SVOCs not marked on COC - will log SVOC per AMD. see back ->

15. SAMPLE CONDITION

Sample(s) _____ were received after the recommended holding time had expired.

Sample(s) _____ were received in a broken container.

Sample(s) _____ were received with bubble >6 mm in diameter. (Notify PM)

16. SAMPLE PRESERVATION

Sample(s) _____ were further preserved in Sample

Receiving to meet recommended pH level(s). Nitric Acid Lot# 051010-HNO₃; Sulfuric Acid Lot# 051010-H₂SO₄; Sodium Hydroxide Lot# 100108 -NaOH; Hydrochloric Acid Lot# 092006-HCl; Sodium Hydroxide and Zinc Acetate Lot# 100108-(CH₃COO)₂ZN/NaOH. What time was preservative added to sample(s)? _____

Client ID	pH	Date	Initials
MW-6	>12	11-22-10	WJS

North Canton Facility

[illegible]

Discrepancies: Cont'd:

^BNAPL1 logged out of order - OK per AMD - archived
per AMD. Per client add PCB's to MW-6, AC-1216, X1-48,
BC(2)-1215, BG-816, B2-89, B3-48, C4-46, and Y(2)-1516.
Per client add BNA's to BC(2)-1215 and B3-48. Per client
log NAPL2 as two layers - LNAPL layer for VOC's, ~~Sediment~~
layer for BNA's.

END OF REPORT

MEMORANDUM

Date: November 8, 2010

To: James Peeples

From: Gregory Cole

Re: CRS-ELYRIA, OH July and September 2010 Sampling Events

A data review was performed on the CRS-ELYRIA analytical results. Samples were collected by Brown and Caldwell (BC) on September 23, 2010 and on September 29, 2010. Analyses were performed by TestAmerica Laboratories, Inc. of North Canton, Ohio. These evaluations do not represent a formal data validation, and no review of raw data has been performed. However, the review provides an overall assessment of data quality and relies on the general data quality review guidelines presented in the USEPA Data Validation guidance^{1,2}, as well as "Quality Control Elements of SW-846 Methods," as summarized in the laboratory reports.

The following have been reviewed:

- Data completeness
- Holding time compliance
- Blanks
- Laboratory Control Samples
- Surrogate Recoveries
- Matrix Spike/ Matrix Spike Duplicate Recoveries
- Field Duplicates

Recommended data qualifiers are consisted with typical USEPA definitions:

- U - The analyte was analyzed for but was not detected above the reported sample quantitation limit (QL)
- J - The concentration is estimated. This is often because the analyte was positively identified at a concentration between the detection limit (DL) and the QL. Estimated results are considered usable.
- UJ - The result is considered not detected at an estimated detection limit.

The following samples were analyzed as part of this sampling event:

¹ National Function Guidelines for Organic Data Review. Office of Emergency and Remedial Response, Washington, DC. EPA/540/R-99/008. October 1999.

² National Function Guidelines for Inorganic Data Review. Office of Emergency and Remedial Response, Washington, DC. EPA/540/R-01/008. July 2002.

BC Sample ID	Laboratory Sample IDs	Analyses Performed
CRS-MW-MW5	A0I270433-001	Volatile Organics by GC/MS (VOC),
CRS-MW-MW50	A0I270433-002	VOC
CRS-MW-MW16	A0I270433-003	VOC
CRS-MW-L2	A0I270433-004	VOC
CRS-MW-L3	A0I270433-005	VOC
Trip Blank	A0I270433-006	VOC
CRS-MW-MW6A	A0I290542-001	VOC
CRS-MW-MW6B	A0I290542-002	VOC
CRS-MW-MW6B (DNAPL)	A0I290542-003	VOC

Summary of Data Quality Review

The analytical data for the samples collected in July and September 2010 are valid and usable. Sample results between the MDL and PQL have been qualified as estimated (J). Details of the data assessment are described below.

1.0 Data Completeness

All samples shipped to the laboratory were received and all requested analyses as indicated on the Chain-of-Custody forms were completed:

TestAmerica provided the data as two (2) laboratory packages, SDG #s: A0I270433 and A0I290542.

All required information was present and legible in the data package.

2.0 Sample Holding Times

Analytical holding times were met for all samples.

3.0 Blanks

The purpose of a blank is to determine the existence and magnitude of contamination resulting from laboratory and field activities. If analytes are identified in the blank samples, all associated data are evaluated to determine whether qualification is necessary. Qualification is only required if the analyte is found in the sample as well as the blank. If more than one blank is associated with a particular result, the various blanks were compared to the method/preparation blank to determine if the contamination is due to the laboratory or to the field. The highest concentration in any of the blanks is used for the qualification.

Blanks reviewed are method blanks to check for laboratory artifacts, ambient blanks to check for atmospheric effects, equipment blanks to check for sampling artifacts, and trip blanks to check for contaminants introduced during transport. The sampling event included one (1) trip blank.

If a compound is found in a blank and the concentration in the associated sample is less than five times the blank concentration (ten times for common laboratory contaminants), the sample result is negated (qualified to a non-detect) at the reporting limit. If the sample concentration is greater than five times/ten times the blank concentration, no action is required.

The following compounds were detected in blanks:

Trip Blank (A0I270433-006)	Acetone	6.6 J ug/L
Trip Blank (A0I270433-006)	Methylene chloride	3.0 ug/L
Method Blank (A0J040000-176)	Acetone	1.4 J ug/L
Method Blank (A0J060000-231)	Methylene chloride	0.44 J ug/L
Method Blank (A0J120000-338)	1,2,4-Trichlorobenzene	65 J ug/Kg

Most associated sample results were well above the levels in the blanks and no data qualification was required. However, the following sample results have been qualified as not detected with an estimated detection limit due to blank contamination.

Sample	Analyte	Sample Result	Qualified Result
CRS-MW-MW5 (A0I270433-001)	Acetone	1.9 ug/L	<1.9 UJ ug/L
CRS-MW-MW50 (A0I270433-002)	Acetone	2.0 ug/L	<2.0 UJ ug/L
CRS-MW-MW16 (A0I270433-003)	Acetone	1.4 ug/L	<1.4 UJ ug/L
CRS-MW-MW6A (A0I290542-001)	Methylene chloride	2100 ug/L	<2100 UJ ug/L
CRS-MW-MW6B (A0I290542-002)	Methylene chloride	3900 ug/L	<3900 UJ ug/L

4.0 Laboratory Control Samples (LCSs)

The LCS consists of selected compounds. The LCS recovery must be within the method-specific acceptance limits. If the LCS recovery is below the acceptance criteria, the affected detected compounds are qualified as estimated (J) and non-detects are qualified as "UJ" (non-detect with an estimated limit of detection). If the LCS recovery is above the acceptance criteria, the affected detected compounds are qualified as estimated "J" and no action is required for non-detects. If more than half the recoveries are outside limits, all detects are qualified as "J" and all non-detects as "UJ." Professional judgment is applied to non-LCS compounds.

All LCSs had acceptable recoveries.

5.0 Surrogate Recoveries

Surrogate compounds are artificial compounds spiked in each analytical batch that are added to determine laboratory performance as well as the matrix effect on the sample. Since the matrix effects are outside of the laboratory's control, the evaluation shall depend on the professional judgment of the reviewer as well as the method technical acceptance criteria.

If any surrogate recovery is not within the acceptance criteria, a reanalysis should have been performed to confirm that the non-compliance was due to matrix effects. If the surrogate remains outside criteria, all detected VOC results should be qualified "J." If the surrogate recoveries are below acceptance limits, non-detects should also be qualified "UJ."

All surrogate recoveries were within acceptance limits with the exception of the recoveries for sample CRS-MW-MW6B (DNAPL). This sample required dilutions to bring the compounds into the calibration range and the surrogates were diluted out. Qualification of results was not warranted.

6.0 Matrix Spike/ Matrix Spike Duplicates (MS/MSDs)

Selected VOC compounds are added to MS/MSD samples and the recoveries are analyzed to check for matrix interferences in the analysis. For organics, either the sampler provides extra sample from a sample point, or the lab selects a sample to spike. No Site samples were analyzed for matrix spike recovery.

7.0 Field Duplicates

One (1) field duplicate pair was collected. CRS-MW-MW50 is a field duplicate of CRS-MW-MW5. In cases where the relative percent difference between duplicate pairs exceeds 50 and at least one result is above the laboratory reporting limit, the results are qualified as estimated. All RPDs between duplicate pairs were below 50 percent and no data qualification was warranted.

Qualified Results

<u>Sample</u>	<u>Parameter</u>	<u>Result and Qualifier</u>
CRS-MW-MW5	Acetone	<1.9 UJ ug/L
CRS-MW-MW5	Chloroform	0.36 J ug/L
CRS-MW-MW5	trans-1,2-Dichloroethene	0.24 J ug/L
CRS-MW-MW5	1,1,1-Trichloroethane	0.41 J ug/L
CRS-MW-MW5	Vinyl chloride	0.45 J ug/L
CRS-MW-MW50	Acetone	<2.0 UJ ug/L
CRS-MW-MW50	Chloroform	0.35 J ug/L
CRS-MW-MW50	trans-1,2-Dichloroethene	0.24 J ug/L
CRS-MW-MW50	1,1,1-Trichloroethane	0.40 J ug/L
CRS-MW-MW50	Vinyl chloride	0.42 J ug/L
CRS-MW-MW16	Acetone	<1.4 UJ ug/L
CRS-MW-MW16	1,1-Dichloroethane	0.29 J ug/L
CRS-MW-MW16	cis-1,2-Dichloroethene	0.42 J ug/L
CRS-MW-MW16	1,1,1-Trichloroethane	0.40 J ug/L
CRS-MW-MW6A	1,2,4-Trimethylbenzene	400 J ug/L
CRS-MW-MW6A	Benzene	1400 J ug/L
CRS-MW-MW6A	Carbon tetrachloride	980 J ug/L
CRS-MW-MW6A	1,1-Dichloroethane	790 J ug/L
CRS-MW-MW6A	1,2-Dichloroethane	600 J ug/L
CRS-MW-MW6A	1,1-Dichloroethene	1100 J ug/L
CRS-MW-MW6A	trans-1,3-Dichloropropene	340 J ug/L
CRS-MW-MW6A	Ethylbenzene	330 J ug/L
CRS-MW-MW6A	Methylene chloride	<2100 UJ ug/L
CRS-MW-MW6A	4-Methyl-2-pentanone	750 J ug/L
CRS-MW-MW6B	1,2,4-Trimethylbenzene	1800 J ug/L
CRS-MW-MW6B	1,3,5-Trimethylbenzene	780 J ug/L
CRS-MW-MW6B	1,1-Dichloroethane	1300 J ug/L
CRS-MW-MW6B	1,1-Dichloroethene	2900 J ug/L
CRS-MW-MW6B	Ethylbenzene	2200 J ug/L

<u>Sample</u>	<u>Parameter</u>	<u>Result and Qualifier</u>
CRS-MW-MW6B	Methylene chloride	<3900 UJ ug/L
CRS-MW-MW6B	Styrene	930 J ug/L
CRS-MW-MW6B	Xylenes (total)	6300 J ug/L
CRS-MW-MW6B (DNAPL)	Naphthalene	92000000 J ug/L
CRS-MW-MW6B (DNAPL)	Benzene	320000 J ug/L
CRS-MW-MW6B (DNAPL)	1,1-Dichloroethene	270000 J ug/L
CRS-MW-MW6B (DNAPL)	Isopropylbenzene	86000 J ug/L
CRS-MW-MW6B (DNAPL)	Methylcyclohexane	360000 J ug/L
CRS-MW-MW6B (DNAPL)	Tetrachloroethene	140000 J ug/L

EPA METHODS

<u>ANALYTE</u>	<u>EPA METHOD</u>
Volatile Organics by GC/MS	SW846 8260B

MEMORANDUM

Date: January 11, 2011

To: Jim Peeples

From: Gregory Cole

Re: CRS-ELYRIA, OH November 2010 Sampling Events

A data review was performed on the CRS-ELYRIA analytical results. Samples were collected by Brown and Caldwell (BC) between November 16, 2010 and November 19, 2010. Analyses were performed by TestAmerica Laboratories, Inc. of North Canton, Ohio. These evaluations do not represent a formal data validation, and no review of raw data has been performed. However, the review provides an overall assessment of data quality and relies on the general data quality review guidelines presented in the USEPA Data Validation guidance^{1,2}, as well as "Quality Control Elements of SW-846 Methods," as summarized in the laboratory reports.

The following have been reviewed:

- Data completeness
- Holding time compliance
- Blanks
- Laboratory Control Samples
- Surrogate Recoveries
- Matrix Spike/ Matrix Spike Duplicate Recoveries
- Field Duplicates

Recommended data qualifiers are consisted with typical USEPA definitions:

- U - The analyte was analyzed for but was not detected above the reported sample quantitation limit (QL)
- J - The concentration is estimated. This is often because the analyte was positively identified at a concentration between the detection limit (DL) and the QL. Estimated results are considered usable.
- UJ - The result is considered not detected at an estimated detection limit.

The following samples were analyzed as part of this sampling event:

¹ National Function Guidelines for Organic Data Review. Office of Emergency and Remedial Response, Washington, DC. EPA/540/R-99/008. October 1999.

² National Function Guidelines for Inorganic Data Review. Office of Emergency and Remedial Response, Washington, DC. EPA/540/R-01/008. July 2002.

BC Sample ID	Laboratory Sample IDs	Analyses Performed
MW-6	A0K230408-001	Semivolatile Organics by GC/MS (SVOC), Polychlorinated Biphenyls (PCB), and Total Cyanide (CN).
GP-74, 12-16'	A0K230408-002	Volatile Organics by GC/MS (VOC), SVOC, PCB, and Percent Solids
GP-57, 4-8'	A0K230408-003	VOC, SVOC, PCB, and Percent Solids
GP-80, 12-15'	A0K230408-004	VOC, SVOC, PCB, and Percent Solids
GP-75, 8-10'	A0K230408-005	VOC, SVOC, PCB, and Percent Solids
GP-56, 8-9'	A0K230408-006	VOC, SVOC, PCB, and Percent Solids
GP-54, 4-8'	A0K230408-007	VOC, SVOC, PCB, and Percent Solids
GP-47, 4-6'	A0K230408-008	VOC, SVOC, PCB, and Percent Solids
MW-6 LNAPL	A0K230408-009	VOC
MW-6 DNAPL	A0K230408-010	SVOC
GP-84, 15-16'	A0K230408-011	VOC, SVOC, PCB, and Percent Solids

Summary of Data Quality Review

The analytical data for the samples collected in November 2010 are valid and usable. Sample results between the MDL and PQL have been qualified as estimated (J). All tentatively identified compounds (TICs) for VOCs and SVOCs are also considered to be estimated (J). Details of the data assessment are described below.

1.0 Data Completeness

The Chain-of-Custody sample IDs and analyses did not match the lab report sample IDs and analyses. The sample IDs on the COCs were based on a grid system used to select sampling locations. These field surface locations were translated into sample borehole locations using the boring number system IDs found in the lab report. The lab provided the conversion key they used to translate the sample IDs. The sample IDs used and the analyses provided in the lab report have been verified to be correct by the project manager. All samples shipped to the laboratory were received and all requested analyses were completed:

TestAmerica provided the data as one (1) laboratory package, SDG #: A0K230408.

All required information was present and legible in the data package.

2.0 Sample Holding Times

Analytical holding times were met for all samples.

3.0 Blanks

The purpose of a blank is to determine the existence and magnitude of contamination resulting from laboratory and field activities. If analytes are identified in the blank samples, all associated data are evaluated to determine whether qualification is necessary. Qualification is only required if the analyte is found in the sample as well as the blank. If more than one blank is associated with a particular result, the various blanks were compared to the method/preparation blank to determine if the contamination is due to the laboratory or to the field. The highest concentration in any of the blanks is used for the qualification.

Blanks reviewed are method blanks to check for laboratory artifacts, ambient blanks to check for atmospheric effects, equipment blanks to check for sampling artifacts, and trip blanks to

check for contaminants introduced during transport. The sampling event included one (1) trip blank.

If a compound is found in a blank and the concentration in the associated sample is less than five times the blank concentration (ten times for common laboratory contaminants), the sample result is negated (qualified to a non-detect) at the reporting limit. If the sample concentration is greater than five times/ten times the blank concentration, no action is required.

The following compounds were detected in blanks:

Method Blank (A0L020000-449)	1,4-Dichlorobenzene	8.3 J ug/Kg
Method Blank (A0L020000-449)	Naphthalene	11 J ug/Kg
Method Blank (A0L080000-315)	Naphthalene	67 J ug/Kg
Method Blank (A0K290000-049)	Naphthalene	19 J ug/Kg
Method Blank (A0L020000-061)	bis(2-Ethylhexyl)phthalate	29 J ug/Kg

Most associated sample results were well above the levels in the blanks and no data qualification was required. However, the following sample results have been qualified as not detected with an estimated detection limit due to blank contamination.

Sample	Analyte	Sample Result	Qualified Result
GP-75, 8-10' (A0K230408-005)	1,4-Dichlorobenzene	11 J ug/Kg	<11 UJ ug/Kg
GP-54, 4-8' (A0K230408-007)	bis(2-Ethylhexyl)phthalate	2400 ug/L	<2400 UJ ug/Kg

4.0 Laboratory Control Samples (LCSs)

The LCS consists of selected compounds. The LCS recovery must be within the method-specific acceptance limits. If the LCS recovery is below the acceptance criteria, the affected detected compounds are qualified as estimated (J) and non-detects are qualified as "UJ" (non-detect with an estimated limit of detection). If the LCS recovery is above the acceptance criteria, the affected detected compounds are qualified as estimated "J" and no action is required for non-detects. If more than half the recoveries are outside limits, all detects are qualified as "J" and all non-detects as "UJ." Professional judgment is applied to non-LCS compounds.

All LCSs had acceptable recoveries.

5.0 Surrogate Recoveries

Surrogate compounds are artificial compounds spiked in each analytical batch that are added to determine laboratory performance as well as the matrix effect on the sample. Since the matrix effects are outside of the laboratory's control, the evaluation shall depend on the professional judgment of the reviewer as well as the method technical acceptance criteria.

If any surrogate recovery is not within the acceptance criteria, a reanalysis should have been performed to confirm that the non-compliance was due to matrix effects. If the surrogate

remains outside criteria, all detected VOC results should be qualified "J." If the surrogate recoveries are below acceptance limits, non-detects should also be qualified "UJ."

All surrogate recoveries were within acceptance limits with the exception of the following:

- Samples MW-6; GP-80, 12-15'; GP-47, 4-6'; MW-6 DNAPL; GP-84, 15-16'; and GP-74, 12-16' for SVOCs required dilutions to bring the compounds into the calibration range and the surrogates were diluted out. Qualification of results was not warranted.
- Samples GP-57, 4-8' and MW-6 LNAPL for VOCs required dilutions to bring the compounds into the calibration range and the surrogates were diluted out. Qualification of results was not warranted.
- Sample MW-6 for PCBs had a high surrogate recovery. However all target compounds were not detected and no data qualification was warranted.

6.0 Matrix Spike/ Matrix Spike Duplicates (MS/MSDs)

Selected VOC compounds are added to MS/MSD samples and the recoveries are analyzed to check for matrix interferences in the analysis. For organics, either the sampler provides extra sample from a sample point, or the lab selects a sample to spike. Sample GP-74, 12-16' was selected for matrix spike analysis for SVOCs. The sample required required dilutions to bring the compounds into the calibration range and the matrix spike compounds were diluted out. Qualification of results was not warranted.

Qualified Results

<u>Sample</u>	<u>Parameter</u>	<u>Result and Qualifier</u>
GP-74, 12-16'	Acetone	16000 J ug/Kg
GP-74, 12-16'	2-Butanone	11000 J ug/Kg
GP-74, 12-16'	cis-1,2-Dichloroethene	5600 J ug/Kg
GP-74, 12-16'	4-Methyl-2-pentanone	1500 J ug/Kg
GP-74, 12-16'	1,2,4-Trimethylbenzene	1900 J ug/Kg
GP-74, 12-16'	1,3,5-Trimethylbenzene	800 J ug/Kg
GP-74, 12-16'	1,1'-Biphenyl	4200 J ug/Kg
GP-57, 4-8'	Benzene	17000 J ug/Kg
GP-57, 4-8'	cis-1,2-Dichloroethene	32000 J ug/Kg
GP-57, 4-8'	Isopropylbenzene	9600 J ug/Kg
GP-57, 4-8'	Methylcyclohexane	25000 J ug/Kg
GP-57, 4-8'	Naphthalene	49000 J ug/Kg
GP-57, 4-8'	Tetrachloroethene	13000 J ug/Kg
GP-57, 4-8'	Trichloroethene	20000 J ug/Kg
GP-57, 4-8'	1,2,4-Trimethylbenzene	25000 J ug/Kg
GP-57, 4-8'	1,3,5-Trimethylbenzene	8400 J ug/Kg
GP-57, 4-8'	1,1'-Biphenyl	2400 J ug/Kg
GP-57, 4-8'	Isophorone	790 J ug/L
GP-80,12-15'	Benzene	480 J ug/Kg
GP-80,12-15'	2-Butanone	650 J ug/Kg
GP-80,12-15'	1,3-Dichlorobenzene	51 J ug/ Kg
GP-80,12-15'	1,4-Dichlorobenzene	350 J ug/ Kg
GP-80,12-15'	cis-1,2-Dichloroethene	670 J ug/Kg
GP-80,12-15'	Methylcyclohexane	230 J ug/Kg
GP-80,12-15'	Tetrachloroethene	92 J ug/Kg
GP-80,12-15'	1,2,4-Trichlorobenzen	120 J ug/ Kg

Sample	Parameter	Result and Qualifier
GP-80, 12-15'	Trichloroethene	330 J ug/Kg
GP-80, 12-15'	Butyl benzyl phthalate	920 J ug/Kg
GP-75, 8-10'	1,4-Dichlorobenzene	<11 UJ ug/Kg
GP-75, 8-10'	1,2-Dichlorobenzene	170 J ug/Kg
GP-75, 8-10'	cis-1,2-Dichloroethene	120 J ug/Kg
GP-75, 8-10'	Isopropylbenzene	200 J ug/Kg
GP-75, 8-10'	Methyl acetate	55 J ug/Kg
GP-75, 8-10'	Methylcyclohexane	98 J ug/Kg
GP-75, 8-10'	Tetrachloroethene	50 J ug/Kg
GP-75, 8-10'	1,2,4-Trichlorobenzene	22 J ug/Kg
GP-75, 8-10'	1,1,1-Trichloroethane	72 J ug/Kg
GP-75, 8-10'	Trichloroethene	44 J ug/Kg
GP-75, 8-10'	1,1'-Biphenyl	110 J ug/Kg
GP-75, 8-10'	2,4-Dimethylphenol	300 J ug/Kg
GP-56, 8-9'	1,2-Dichlorobenzene	750 J ug/Kg
GP-56, 8-9'	cis-1,2-Dichloroethene	160 J ug/Kg
GP-56, 8-9'	Isopropylbenzene	250 J ug/Kg
GP-56, 8-9'	Methylcyclohexane	220 J ug/Kg
GP-56, 8-9'	Tetrachloroethene	220 J ug/Kg
GP-56, 8-9'	1,3,5-Trimethylbenzene	1500 J ug/Kg
GP-56, 8-9'	bis(2-Ethylhexyl)phthalate	89 J ug/Kg
GP-54, 4-8'	Acetone	820 J ug/Kg
GP-54, 4-8'	2-Butanone	520 J ug/Kg
GP-54, 4-8'	Carbon disulfide	150 J ug/Kg
GP-54, 4-8'	Cyclohexane	160 J ug/Kg
GP-54, 4-8'	1,2-Dichlorobenzene	460J ug/Kg
GP-54, 4-8'	1,3-Dichlorobenzene	63 J ug/Kg
GP-54, 4-8'	1,4-Dichlorobenzene	170 J ug/Kg
GP-54, 4-8'	1,1-Dichloroethene	400 J ug/Kg
GP-54, 4-8'	Ethylbenzene	320 J ug/Kg
GP-54, 4-8'	Isopropylbenzene	53 J ug/Kg
GP-54, 4-8'	Methyl acetate	210 J ug/Kg
GP-54, 4-8'	Methylcyclohexane	280 J ug/Kg
GP-54, 4-8'	Naphthalene	230 J ug/Kg
GP-54, 4-8'	Toluene	430 J ug/Kg
GP-54, 4-8'	1,2,4-Trichlorobenzene	140 J ug/Kg
GP-54, 4-8'	Butyl benzyl phthalate	470 J ug/Kg
GP-47, 4-6'	1,3-Dichlorobenzene	41 J ug/Kg
GP-47, 4-6'	cis-1,2-Dichloroethene	30 J ug/Kg
GP-47, 4-6'	Isopropylbenzene	66 J ug/Kg
GP-47, 4-6'	Methylcyclohexane	25 J ug/Kg
GP-47, 4-6'	Tetrachloroethene	130 J ug/Kg
GP-47, 4-6'	1,2,4-Trichlorobenzene	15 J ug/Kg
GP-47, 4-6'	1,1,1-Trichloroethane	140 J ug/Kg
GP-47, 4-6'	Butyl benzyl phthalate	1800 J ug/Kg
MW-6 LNAPL	Toluene	440000 J ug/Kg
MW-6 LNAPL	1,3,5-Trimethylbenzene	820000 J ug/Kg
MW-6 LNAPL	Xylenes (total)	430000 J ug/Kg
MW-6 DNAPL	1,1'-Biphenyl	130000 J ug/Kg

<u>Sample</u>	<u>Parameter</u>	<u>Result and Qualifier</u>
GP-84,15-16'	2-Butanone	7900 J ug/Kg
GP-84,15-16'	1,1-Dichloroethane	1600 J ug/Kg
GP-84,15-16'	cis-1,2-Dichloroethene	11000 J ug/Kg
GP-84,15-16'	Styrene	3600 J ug/Kg
GP-84,15-16'	1,1,1-Trichloroethane	9900 J ug/Kg
GP-84,15-16'	Trichloroethene	740 J ug/Kg
GP-84,15-16'	1,2,4-Trimethylbenzene	14000 J ug/Kg
GP-84,15-16'	1,3,5-Trimethylbenzene	5200 J ug/Kg

EPA METHODS

<u>ANALYTE</u>	<u>EPA METHOD</u>
Volatile Organics by GC/MS	SW846 8260B
Semivolatile Organic Compounds by GC/MS	SW846 8270C
PCBs	SW846 8082
Cyanide, total	SW846 9012A
Percent Solids	MCAWW 160.3 MOD

GROUNDWATER PURGE AND SAMPLING FIELD DATA SHEET

1. PROJECT INFORMATION

WELL ID: MW-5

Project Number: 139452 Task Number: 350

Date: 9/22/10 - 9/23/10 Time: 16:05 (9/22)

Client: CRS Group

Personnel: James Peoples

Project Location: CRS Elyria, OH

Weather: 85°, sunny

2. WELL DATA

Casing Diameter: 2" inches Type of Casing: AVC

Screen Diameter: 2" inches (d) Type of Screen: AVC Screen Length: _____

Total Depth of Well from TOC: 23.52 feet

Depth to Static Water from TOC: 15.45 feet

Depth to Product from TOC: NA feet

Length of Water Column (h): 8.07 feet Calculated Casing Volume: 1.35 gal (3 to 5 times one well volume)

Purge Volume Calculation (one casing volume = $0.041d^2h$): $1.35 \text{ gal} \times 3 = 4.04 \text{ gallons}$
for a 3 volume purge

Note: 2-inch well = 0.167 gal/ft 4-inch well = 0.667 gal/ft

3. PURGE DATA

Purge Method: Bailer

Materials: Pump/Bailer Poly bailer

Materials: Rope/Tubing Nylon Rope

Was well purged dry? ☐ Yes ☒ No Pumping Rate: _____ gal/min

Equipment

Model(s)

1. Horiba - U-25

2. _____

Time	Cum. Gallons Removed	pH	Temp (Units)	Spec. Cond. (Units)	Eh (Units)	DO (Units)	Turbidity (NTU)	Other: <u>TD5</u>	Comments
<u>16:12</u>	<u>1.5</u>	<u>6.74</u>	<u>20.63</u>	<u>0.738</u>	<u>136</u>	<u>1.49</u>	<u>>800</u>	<u>0.473</u>	<u>9/22/10</u>
<u>16:26</u>	<u>3.0</u>	<u>6.72</u>	<u>20.71</u>	<u>0.739</u>	<u>139</u>	<u>1.49</u>	<u>>800</u>	<u>0.473</u>	<u>9/22/10</u>
<u>16:37</u>	<u>5.0</u>	<u>6.85</u>	<u>17.86</u>	<u>1.00</u>	<u>132</u>	<u>3.80</u>	<u>>800</u>	<u>0.641</u>	<u>9/22/10</u>
<u>16:50</u>	<u>7.0</u>	<u>6.79</u>	<u>18.19</u>	<u>1.01</u>	<u>134</u>	<u>3.97</u>	<u>>800</u>	<u>0.648</u>	<u>9/22/10</u>
<u>13:58</u>	<u>8.5</u>	<u>6.78</u>	<u>20.42</u>	<u>0.922</u>	<u>244</u>	<u>2.03</u>	<u>438</u>	<u>0.591</u>	<u>9/23/10</u>
<u>14:08</u>	<u>10.0</u>	<u>6.89</u>	<u>18.78</u>	<u>1.07</u>	<u>235</u>	<u>3.36</u>	<u>364</u>	<u>0.688</u>	<u>9/23/10</u>
<u>14:15</u>	<u>11.0</u>	<u>6.89</u>	<u>18.51</u>	<u>1.09</u>	<u>232</u>	<u>3.62</u>	<u>310</u>	<u>0.695</u>	<u>9/23/10 sampled</u>

4. SAMPLING DATA

Method(s): Bailer poured into 40 ml VOA vials

Materials: Pump/Bailer Poly bailer

Materials: Tubing/Rope Nylon rope

Depth to Water at Time of Sampling: _____ Field Filtered? ☐ Yes ☒ No

Sample ID: CRS-MW-MW5 Sample Time: 14:16/14:20 # of Containers: 3+3

Duplicate Sample Collected? ☒ Yes ☐ No ID: dup.

Analyses Requested:

VOCs

5. COMMENTS

Duplicate ID CRS-MW-MW50

GROUNDWATER PURGE AND SAMPLING FIELD DATA SHEET

1. PROJECT INFORMATION

WELL ID: MW-16

Project Number: 139452 Task Number: 350

Date: 9/22/10 9/23/10 Time: 7:21

Client: CRS Group

Personnel: James Peoples

Project Location: CRS Elyria, OH

Weather: 85°, sunny

2. WELL DATA

Casing Diameter: 4" inches Type of Casing: AVC

Screen Diameter: 4" inches (d) Type of Screen: AVC Screen Length: _____

Total Depth of Well from TOC: 17.89 feet

Depth to Static Water from TOC: 28.15 feet

Depth to Product from TOC: NA feet

Length of Water Column (h): 10.26 feet Calculated Casing Volume: 6.84 gal (3 to 5 times one well volume)

Purge Volume Calculation (one casing volume = $0.041d^2h$):

$$6.84 \text{ gal / Volume} \times 3 = 20.53 \text{ gal}$$

for 3 volume purge.

Note: 2-inch well = 0.167 gal/ft 4-inch well = 0.667 gal/ft

3. PURGE DATA

Purge Method: Bailer

Equipment Model(s)

Materials: Pump/Bailer Poly bailer

1. Horiba U-25

Materials: Rope/Tubing Nylon Rope

2. _____

Was well purged dry? ☐ Yes ☒ No Pumping Rate: _____ gal/min

Time	Cum. Gallons Removed	pH	Temp (Units)	Spec. Cond. (Units)	Eh (Units)	DO (Units)	Turbidity (NTU)	Other: <u>TD5</u>	Comments
7:21	2.0	6.64	16.85	1.25	192	2.03	206	0.803	
7:39	6.0	6.64	15.46	1.90	189	1.12	604	1.22	
8:01	10.0	6.75	15.97	3.54	185	3.52	7800	2.27	
8:22	12.0	7.07	15.55	3.91	185	2.78	475	2.51	bailing low level
15:06	15.5	6.65	17.84	4.23	229	7.52	140	2.52	
15:18	18.0	6.63	15.96	4.45	230	7.82	156	2.84	
15:28	20.5	6.69	15.62	4.74	228	8.23	152	3.03	sampled

4. SAMPLING DATA

Method(s): Bailer poured into 40 ml VOA vials

Materials: Pump/Bailer Poly bailer

Materials: Tubing/Rope Nylon rope

Depth to Water at Time of Sampling: _____ Field Filtered? ☐ Yes ☒ No

Sample ID: CRS-MW-MW16 Sample Time: 15:30 # of Containers: 3

Duplicate Sample Collected? ☐ Yes ☒ No ID: _____

Analyses Requested:

VOCs

5. COMMENTS

GROUNDWATER PURGE AND SAMPLING FIELD DATA SHEET

1. PROJECT INFORMATION

WELL ID: L-2

Project Number: 139452 Task Number: 350

Date: 9/22/10 - 9/23/10 Time: 18:16

Client: CRS Group

Personnel: James Peoples

Project Location: CRS Elyria, OH

Weather: 85°, sunny

2. WELL DATA

Casing Diameter: 4" inches Type of Casing: AVC

Screen Diameter: 4" inches (d) Type of Screen: AVC Screen Length: _____

Total Depth of Well from TOC: 11.44 feet

Depth to Static Water from TOC: 25.48 feet

Depth to Product from TOC: 14.04 NA feet

Length of Water Column (h): 14.04 feet Calculated Casing Volume: 9.36 gal (3 to 5 times one well volume)

Purge Volume Calculation (one casing volume = $0.041d^2h$):

$$9.36 \text{ gal / volume} - 3 \text{ volume} = 28.09 \text{ gal}$$

Note: 2-inch well = 0.167 gal/ft 4-inch well = 0.667 gal/ft

3. PURGE DATA

Purge Method: Bailer

Equipment Model(s)

Materials: Pump/Bailer Poly bailer

1. Horiba U-25

Materials: Rope/Tubing Nylon Rope

2. _____

Was well purged dry? ☐ Yes ☒ No Pumping Rate: _____ gal/min

Time	Cum. Gallons Removed	pH	Temp (Units)	Spec. Cond. (Units)	Eh (Units)	DO (Units)	Turbidity (NTU)	Other: <u>TD5</u>	Comments
18:16	3.0	6.82	21.45	6.80	213	9.90	>800	4.29	9/22/10
18:29	7.5	6.83	20.27	6.77	225	3.96	>800	4.27	9/22/10
18:36	10	6.91	19.82	6.52	233	3.74	>800	4.11	9/22/10
18:59	15	7.10	19.76	6.70	264	4.25	>800	3.91	9/22/10
16:13	20	6.75	22.03	6.70	227	3.72	772	4.22	9/23/10
16:22	25	6.79	22.50	6.29	239	3.77	7800	3.96	9/23/10
16:32	28	6.84	22.54	6.07	246	8.37	7800	3.81	9/23/10 sampled

4. SAMPLING DATA

Method(s): Bailer poured into 40 ml VOA vials

Materials: Pump/Bailer Poly bailer

Materials: Tubing/Rope Nylon rope

Depth to Water at Time of Sampling: _____ Field Filtered? ☐ Yes ☒ No

Sample ID: CRS-MW-L2 Sample Time: 16:34 # of Containers: 3

Duplicate Sample Collected? ☐ Yes ☒ No ID: _____

Analyses Requested:

VOCs

5. COMMENTS

GROUNDWATER PURGE AND SAMPLING FIELD DATA SHEET

1. PROJECT INFORMATION

WELL ID: L-3

Project Number: 139452 Task Number: 350

Date: 9/23/10

Time: 9:17

Client: CRS Group

Personnel: James Peeples

Project Location: CRS Elyria, OH

Weather: 85°, sunny

2. WELL DATA

Casing Diameter: 4" inches

Type of Casing: PVC

Screen Diameter: 4" inches (d)

Type of Screen: PVC

Screen Length: _____

Total Depth of Well from TOC: 11.44 feet

Depth to Static Water from TOC: 25.48 feet

Depth to Product from TOC: NA feet

Length of Water Column (h): 14.01 feet Calculated Casing Volume: 9.36 gal (3 to 5 times one well volume)

Purge Volume Calculation (one casing volume = $0.041d^2h$):

3 volume purge = 28.09 gal.

Note: 2-inch well = 0.167 gal/ft 4-inch well = 0.667 gal/ft

3. PURGE DATA

Purge Method: Bailer

Equipment

Model(s)

Materials: Pump/Bailer

Poly bailer

1. Horiba U-25

Materials: Rope/Tubing

Nylon Rope

2. _____

Was well purged dry? ☐ Yes ☒ No

Pumping Rate:

gal/min

Time	Cum. Gallons Removed	pH	Temp (Units)	Spec. Cond. (Units)	Eh (Units)	DO (Units)	Turbidity (NTU)	Other: <u>TDS</u>	Comments
9:17	2.0	5.60	18.81	5.15	228	3.39	23.0	3.25	
9:30	5.0	5.27	18.79	5.35	274	8.34	48.2	3.37	
9:50	10.0	5.44	18.69	5.47	284	9.59	56.1	3.45	
10:02	12.0	5.47	18.56	5.53	283	1.38	40.4	3.48	
17:10	21	5.33	22.66	5.09	274	1.27	84.3	3.20	
17:20	25	5.45	21.63	5.35	279	1.54	73.1	3.37	
17:30	28	5.60	20.13	5.51	278	2.97	95.9	3.47	

4. SAMPLING DATA

Method(s): Bailer poured into 40 ml VOA vials

Materials: Pump/Bailer

Poly bailer

Materials: Tubing/Rope

Nylon Rope

Depth to Water at Time of Sampling: _____

Field Filtered? ☐ Yes ☒ No

Sample ID: CRS-MW-L3

Sample Time: 17:35

of Containers: 3

Duplicate Sample Collected? ☐ Yes ☒ No

ID: _____

VOCs

5. COMMENTS

GROUNDWATER PURGE AND SAMPLING FIELD DATA SHEET

1. PROJECT INFORMATION

WELL ID: MW-6

Project Number: 139452 Task Number: _____

Date: 9/29/10 Time: 10:05

Client: CRS PRP GROUP

Personnel: Jim Peoples / Jim Krebs

Project Location: Elyria, Ohio

Weather: sunny, 75, breezy

2. WELL DATA

Casing Diameter: 2 inches Type of Casing: PVC

Screen Diameter: 2 inches (d) Type of Screen: PVC Screen Length: 10'

Total Depth of Well from TOC: NM feet

Depth to Static Water from TOC: NM feet

Depth to Product from TOC: NM feet

Length of Water Column (h): _____ feet Calculated Casing Volume: _____ gal (3 to 5 times one well volume)

Purge Volume Calculation (one casing volume = $0.041d^2h$):

Just using bailer to try to obtain an LNAPL and a DNAPL sample.

Note: 2-inch well = 0.167 gal/ft 4-inch well = 0.667 gal/ft

3. PURGE DATA

Purge Method: Bailer (disposable P.E.)

Equipment
Model(s)

Materials: Pump/Bailer _____

1. _____

Materials: Rope/Tubing Nylon rope

2. _____

Was well purged dry? ☐ Yes ☒ No

Pumping Rate: _____ gal/min only purging small volume.

Time	Cum. Gallons Removed	pH	Temp (Units)	Spec. Cond. (Units)	Eh (Units)	DO (Units)	Turbidity (NTU)	Other:	Comments
									<u>No purging - just collecting LNAPL/DNAPL sample</u>

4. SAMPLING DATA

Method(s): bailer

Materials: Pump/Bailer P.E. disposable

Materials: Tubing/Rope nylon rope

Depth to Water at Time of Sampling: NM Field Filtered? ☐ Yes ☒ No

Sample ID: _____ Sample Time: 10:30/11:15 # of Containers: 2-4 mL VOA's

Duplicate Sample Collected? ☐ Yes ☒ No ID: _____

Analyses Requested:

VOCs
[SVOCs if enough sample is present]

5. COMMENTS

Analysis of DNAPL and water in contact with DNAPL requested. Analysis of LNAPL from 2nd vial.

GROUNDWATER PURGE AND SAMPLING FIELD DATA SHEET

1. PROJECT INFORMATION

WELL ID: m-6

Project Number: 17452 Task Number: _____

Date: 11/16/10 Time: _____

Client: CPS

Personnel: J. Warden, J. Peoples (BCL)

Project Location: Elyria OH

Weather: Rain, 45°

2. WELL DATA

Casing Diameter: 2 inches Type of Casing: PVC
 Screen Diameter: 2 inches (d) Type of Screen: PVC Screen Length: 10'
 Total Depth of Well from TOC: 22.87 feet
 Depth to Static Water from TOC: 17.03 feet
 Depth to Product from TOC: ND feet
 Length of Water Column (h): 5.84 feet Calculated Casing Volume: 0.98 gal (3 to 5 times one well volume)

Purge Volume Calculation (one casing volume = $0.041d^2h$):

$$5.84 \times 0.167 = 0.98$$

Note: 2-inch well = 0.167 gal/ft 4-inch well = 0.667 gal/ft

3. PURGE DATA

Purge Method: Peristaltic Equipment: _____
 Materials: Pump/Bailer Silicone tubing Model(s): _____
 Materials: Rope/Tubing PE 1. _____
 2. _____
 Was well purged dry? ☐ Yes ☒ No Pumping Rate: _____ gal/min

Time	Cum. Gallons Removed	pH	Temp (Units)	Spec. Cond. (Units)	Eh (Units)	DO (Units)	Turbidity (NTU)	Other:	Comments

4. SAMPLING DATA

Method(s): Peristaltic
 Materials: Pump/Bailer Silicone tubing
 Materials: Tubing/Rope PE
 Depth to Water at Time of Sampling: NM Field Filtered? ☐ Yes ☒ No
 Sample ID: NAPL1, NAPL2 Sample Time: 16:00, 16:10 # of Containers: 2
 Duplicate Sample Collected? ☐ Yes ☐ No ID: _____

Analyses Requested:

VOC, SVOC

5. COMMENTS

collected samples of LNAPL (NAPL1) and DNAPL (NAPL2) from m-6.

GROUNDWATER PURGE AND SAMPLING FIELD DATA SHEET

1. PROJECT INFORMATION

WELL ID: Mu-6

Project Number: 09452 Task Number: _____

Date: 11/16/10 Time: 12:20

Client: CRS

Personnel: J Warburton (BC)

Project Location: Elgin, OH

Weather: Sunny 40°

2. WELL DATA

Casing Diameter: 2 inches

Type of Casing: PVC

Screen Diameter: 2 inches (d)

Type of Screen: PVC

Screen Length: 10'

Total Depth of Well from TOC: 22.87 feet

Depth to Static Water from TOC: 17.23 feet

Depth to Product from TOC: ND feet

Length of Water Column (h): 5.64 feet

Calculated Casing Volume: 0.94 gal (3 to 5 times one well volume)

Purge Volume Calculation (one casing volume = $0.041d^2h$):

$$5.64' \times 0.167 = 0.94 \text{ gallons}$$

Note: 2-inch well = 0.167 gal/ft 4-inch well = 0.667 gal/ft

3. PURGE DATA

Purge Method: Peristaltic

Model(s): _____

Materials: Pump/Bailer PE Silicone tubing

1. _____

Materials: Rope/Tubing PE

2. _____

Was well purged dry? ☐ Yes ☒ No

Pumping Rate: 500 ^{ml} gal/min

Time	Cum. Gallons Removed	pH	Temp (Units)	Spec. Cond. (Units)	Eh (Units)	DO (Units)	Turbidity (NTU)	Other: <u>DTN</u>	Comments
<u>12:20</u>	<u>0</u>	<u>NM</u>	<u>—</u>	<u>—</u>	<u>—</u>	<u>—</u>	<u>—</u>	<u>17.23</u>	
<u>12:28</u>	<u>1</u>	<u>NM</u>	<u>—</u>	<u>—</u>	<u>—</u>	<u>—</u>	<u>—</u>	<u>18.62</u>	
<u>12:36</u>	<u>2</u>	<u>NM</u>	<u>—</u>	<u>—</u>	<u>—</u>	<u>—</u>	<u>—</u>	<u>18.78</u>	
<u>12:44</u>	<u>3</u>	<u>NM</u>	<u>—</u>	<u>—</u>	<u>—</u>	<u>—</u>	<u>—</u>	<u>18.82</u>	

4. SAMPLING DATA

Method(s): Peristaltic

Analyses Requested:

Materials: Pump/Bailer Silicone tubing

SVOCs, cyanide

Materials: Tubing/Rope PE

Depth to Water at Time of Sampling: 18.82

Field Filtered? ☐ Yes ☒ No

Sample ID: Mu-6

Sample Time: 12:44

of Containers: 3

Duplicate Sample Collected? ☐ Yes ☒ No

5. COMMENTS

Appendix E: Borings Logs from November 2010 Investigation

WELL CONSTRUCTION

Diameter (ID): 1"

Material: PVC

Coupling: NA

Hole Diameter: 3.25"

WELL DEVELOPMENT

Methods: NA

Duration: NA

Vol. Purged: NA

Slug Test: NA

Project: Chemical Recovery SystemsBC Personnel: J. Warburton

Client: CRS Performing Parties

Location: Elyria, OH

Start Date: 11/17/10

Contractor: Frontz Drilling

Finish Date: 11/17/10

Equipment: Geoprobe 6620 DT

Project No.: 139452

Method: Direct Push

SURVEY DATA

Ground:

North:

TPVC:

East:

Depth (ft)	Well Construction	Symbol	Lithologic Description	Sample				Remarks
				Run	Type	PID (ppm)	Recovery (ft)	
-2			Ground Surface					
-1			(0-2.0') Red brick fragments and fill, black, dry					
0				1	DP	NM	2.0	
1								
2								
3								
4			(4.0-6.0') Sand and gravel w/ sandstone fragments, brown, moist.					
5			Refusal at 6.0'	2	DP	NM	2.0	
6			End of Log					
7								
8								
9								
10								

WELL CONSTRUCTION

Diameter (ID): 1"

Material: PVC

Coupling: NA

Hole Diameter: 3.25"

WELL DEVELOPMENT

Methods: NA

Duration: NA

Vol. Purged: NA

Slug Test: NA

Project: Chemical Recovery SystemsBC Personnel: J. Warburton

Client: CRS Performing Parties

Location: Elyria, OH

Start Date: 11/17/10

Contractor: Frontz Drilling

Finish Date: 11/17/10

Equipment: Geoprobe 6620 DT

Project No.: 139452

Method: Direct Push

SURVEY DATA

Ground:

North:

TPVC:

East:

Depth (ft)	Well Construction	Symbol	Lithologic Description	Sample				Remarks
				Run	Type	PID (ppm)	Recovery (ft)	
-2	<p>1" PVC</p> <p>Hydrated bentonite chips</p> <p>Sand</p>		Ground Surface					
-1			(0-1.0') Red brick fragments, dry					
0			(1.0-1.4') Sand and gravel, brown, HC odor					
1				1	DP	66.8	1.4	
2								
3								
4			(4.0-6.0') Silty clay, some sand and gravel, reddish brown, moist					
5								
6			(6.0-6.5') Weathered sandstone, brown, moist, HC odor	2	DP	253.1	2.5	
7			Refusal at 6.5'					
8			End of Log					
9								
10								

WELL CONSTRUCTION

Diameter (ID): 1"

Material: PVC

Coupling: NA

Hole Diameter: 3.25"

WELL DEVELOPMENT

Methods: NA

Duration: NA

Vol. Purged: NA

Slug Test: NA

Project: Chemical Recovery SystemsBC Personnel: J. Warburton

Client: CRS Performing Parties

Location: Elyria, OH

Start Date: 11/17/10

Contractor: Frontz Drilling

Finish Date: 11/17/10

Equipment: Geoprobe 6620 DT

Project No.: 139452

Method: Direct Push

SURVEY DATA

Ground:

North:

TPVC:

East:

Depth (ft)	Well Construction	Symbol	Lithologic Description	Sample				Remarks
				Run	Type	PID (ppm)	Recovery (ft)	
-2	<p>1" PVC</p> <p>Hydrated bentonite chips</p> <p>Sand</p>		Ground Surface					
-1			(0-0.8') Red brick fragments, dry					
0			(0.8-1.0') Sandstone fragments, light gray, moist					
1				1	DP	1.7	1.0	
2								
3								
4			(4.0-5.9') Sandstone fragments, yellowish brown, moist					
5			(4.9-5.9') Fill, slag, brown, stained 5.6-5.7', damp					
6			(5.9-6.5') Sandstone, weathered, brown, moist	2	DP	6.2	2.5	
7			Refusal at 6.5'					
8			End of Log					
9								
10								

WELL CONSTRUCTION

Diameter (ID): 1"

Material: PVC

Coupling: NA

Hole Diameter: 3.25"

WELL DEVELOPMENT

Methods: NA

Duration: NA

Vol. Purged: NA

Slug Test: NA

Project: Chemical Recovery SystemsBC Personnel: J. Warburton

Client: CRS Performing Parties

Location: Elyria, OH

Start Date: 11/17/10

Contractor: Frontz Drilling

Finish Date: 11/17/10

Equipment: Geoprobe 6620 DT

Project No.: 139452

Method: Direct Push

SURVEY DATA

Ground:

North:

TPVC:

East:

Depth (ft)	Well Construction	Symbol	Lithologic Description	Sample				Remarks
				Run	Type	PID (ppm)	Recovery (ft)	
-2	<p>1" PVC</p> <p>Hydrated bentonite chips</p> <p>Sand</p>		Ground Surface					
-1			(0-0.2') Topsoil and gravel, brown, moist					
0			(0.2-2.2') Fill- brick fragments and silty clay, occasional sandstone, gravel, dark brown, moist					
1			(2.2-2.8') Sandy silty clay, occasional sandstone fragments, brown, moist	1	DP	6.4	2.8	
2								
3								
4			(4.0-5.3') Sand, sandstone fragments, brown, moist					
5			(5.3-5.9') Sandstone and sandy clay, brown, moist					
6			(5.9-6.7') Silty clay, sandstone fragments, moist, slight HC odor	2	DP	119.3	2.9	
7			(6.7-6.9') Sandstone, brown, moist					
8			Refusal at 6.9'					
9			End of Log					
10								

WELL CONSTRUCTION

Diameter (ID): 1"

Material: PVC

Coupling: NA

Hole Diameter: 3.25"

WELL DEVELOPMENT

Methods: NA

Duration: NA

Vol. Purged: NA

Slug Test: NA

Project: Chemical Recovery SystemsBC Personnel: J. Warburton

Client: CRS Performing Parties

Location: Elyria, OH

Start Date: 11/17/10

Contractor: Frontz Drilling

Finish Date: 11/17/10

Equipment: Geoprobe 6620 DT

Project No.: 139452

Method: Direct Push

SURVEY DATA

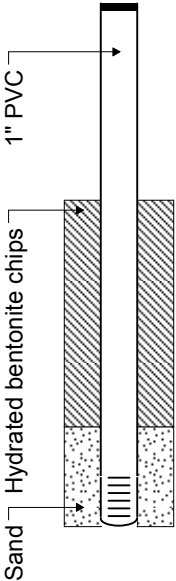
Ground:

North:

TPVC:

East:

Depth (ft)	Well Construction	Symbol	Lithologic Description	Sample				Remarks
				Run	Type	PID (ppm)	Recovery (ft)	
-2			Ground Surface					
-1			(0-0.2') Fill and topsoil, brown, moist					
0			(0.4-2.0') Silty sandy clay, dark brown, moist					
1			(2.0-2.4') Clayey fine sand, sandstone fragments, brown, moist	1	DP	0.1	2.4	
2								
3								
4			(4.0-5.3') Sand, little clay, sandstone gravel, brown, moist					
5			(5.3-5.9') Silty clay, dark brown, HC odor					
6			(5.9-6.0') Sandstone, brown, moist	2	DP	26.3	2.0	
7			Refusal at 7.3'					
8			End of Log					
9								
10								

<div><div><div>Brown AND Caldwell</div></div><div>4700 Lakehurst Court, Suite 100 Dublin, OH 43016</div></div>			Boring/Hole #: GP-51		Page No.: 1 of 1			
<div>Project: Chemical Recovery SystemsBC Personnel: J. Warburton</div> <div>Client: CRS Performing PartiesLocation: Elyria, OH</div> <div>Start Date: 11/17/10Contractor: Frontz Drilling</div> <div>Finish Date: 11/17/10Equipment: Geoprobe 6620 DT</div> <div>Project No.: 139452Method: Direct Push</div>			<div>WELL CONSTRUCTION</div> <div>Diameter (ID): 1"</div> <div>Material: PVC</div> <div>Coupling: NA</div> <div>Hole Diameter: 3.25"</div>		<div>WELL DEVELOPMENT</div> <div>Methods: NA</div> <div>Duration: NA</div> <div>Vol. Purged: NA</div> <div>Slug Test: NA</div>			
			SURVEY DATA		Ground:North:			
			TPVC:		East:			
Depth (ft)	Well Construction	Symbol	Lithologic Description	Sample				Remarks
				Run	Type	PID (ppm)	Recovery (ft)	
-2			Ground Surface					
-1			(0-0.8') Concrete and gravel base, dry					
0			(0.8-1.2') Red brick fill, damp					
1			(1.2-2.8') Concrete fragments					
2				1	DP		2.9	
3			(2.8-2.9') Sandstone, brown					
4			(4.0-4.4') Weathered sandstone, brownish-gray					
5			Refusal at 4.4'					
6				2	DP	7.5	0.4	
7								
8			End of Log					
9								
10								

WELL CONSTRUCTION

Diameter (ID): 1"

Material: PVC

Coupling: NA

Hole Diameter: 3.25"

WELL DEVELOPMENT

Methods: NA

Duration: NA

Vol. Purged: NA

Slug Test: NA

Project: Chemical Recovery SystemsBC Personnel: J. Warburton

Client: CRS Performing Parties

Location: Elyria, OH

Start Date: 11/17/10

Contractor: Frontz Drilling

Finish Date: 11/17/10

Equipment: Geoprobe 6620 DT

Project No.: 139452

Method: Direct Push

SURVEY DATA

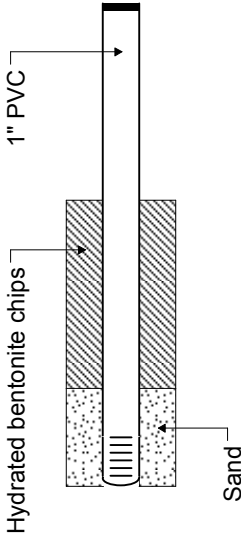

Ground:

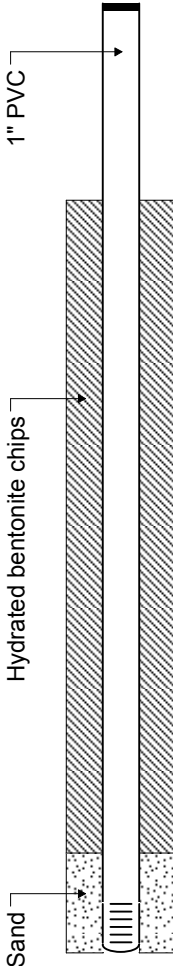
North:

TPVC:

East:

Depth (ft)	Well Construction	Symbol	Lithologic Description	Sample				Remarks
				Run	Type	PID (ppm)	Recovery (ft)	
-2			Ground Surface					
-1			(0-1.0') Concrete and gravel base, dry					
0			(1.0-1.9') Concrete fragments					
1			(1.9-2.0') Sandstone fragments, moist, HC odor	1	DP	28.2	2.0	
2								
3								
4			(4.0-4.8') Slag, fill, black, moist					
5			(4.8-6.5') Fill- clayey sand, sandstone fragments, brown, moist, HC odor					
6			Refusal at 7.9'	2	DP	3.9	2.5	
7								
8			End of Log					
9								
10								

<div><div><div>Brown AND Caldwell</div></div><div><div>4700 Lakehurst Court, Suite 100</div><div>Dublin, OH 43016</div></div></div>			<div><div>Boring/Hole #: GP-53</div><div>Page No.: 1 of 1</div></div>					
<div><div>Project: Chemical Recovery Systems</div><div>BC Personnel: J. Warburton</div><div>Client: CRS Performing Parties</div><div>Location: Elyria, OH</div><div>Start Date: 11/17/10</div><div>Contractor: Frontz Drilling</div><div>Finish Date: 11/17/10</div><div>Equipment: Geoprobe 6620 DT</div><div>Project No.: 139452</div><div>Method: Direct Push</div></div>			<div><div><div>WELL CONSTRUCTION</div><div>Diameter (ID): 1"</div><div>Material: PVC</div><div>Coupling: NA</div><div>Hole Diameter: 3.25"</div></div><div><div>WELL DEVELOPMENT</div><div>Methods: NA</div><div>Duration: NA</div><div>Vol. Purged: NA</div><div>Slug Test: NA</div></div></div>					
			<div><div>SURVEY DATA</div><div>Ground:</div><div>TPVC:</div><div>North:</div><div>East:</div></div>					
Depth (ft)	Well Construction	Symbol	Lithologic Description	Sample				Remarks
				Run	Type	PID (ppm)	Recovery (ft)	
-2			Ground Surface					
(0-0.5') Concrete base, damp								
(0.5-2.5') Crushed concrete base and sandstone fragments, gray, damp.								
Refusal at 2.9'								
			1	DP	8.5	2.5		
3								
4			End of Log					
5								
6								
7								
8								
9								
10								

<div><div><div>Brown AND Caldwell</div></div><div><div>4700 Lakehurst Court, Suite 100 Dublin, OH 43016</div></div></div>			Boring/Hole #: GP-54		Page No.: 1 of 1			
<div><div>Project: Chemical Recovery SystemsBC Personnel: J. Warburton</div><div>Client: CRS Performing PartiesLocation: Elyria, OH</div><div>Start Date: 11/17/10Contractor: Frontz Drilling</div><div>Finish Date: 11/17/10Equipment: Geoprobe 6620 DT</div><div>Project No.: 139452Method: Direct Push</div></div>			WELL CONSTRUCTION		WELL DEVELOPMENT			
			Diameter (ID): 1"		Methods: NA			
			Material: PVC		Duration: NA			
			Coupling: NA		Vol. Purged: NA			
			Hole Diameter: 3.25"		Slug Test: NA			
			SURVEY DATA					
			Ground:		North:			
			TPVC:		East:			
Depth (ft)	Well Construction	Symbol	Lithologic Description	Sample				Remarks
				Run	Type	PID (ppm)	Recovery (ft)	
-2			Ground Surface					
-1			(0-0.4') Concrete base, damp					
0			(0.4-1.2') Fill- crushed concrete, sand, and gravel, gray, moist					
1								
2				1	DP	38.6	1.2	
3								
4								
5				(4.0-5.2') Fill- clayey sand, gravel, sandstone fragments, brown, moist, HC odor				
6				Refusal at 7.6'				
7								
8					2	DP	224.2	1.2
9								
10			End of Log					

WELL CONSTRUCTION

Diameter (ID): 1"

Material: PVC

Coupling: NA

Hole Diameter: 3.25"

WELL DEVELOPMENT

Methods: NA

Duration: NA

Vol. Purged: NA

Slug Test: NA

Project: Chemical Recovery Systems BC Personnel: J. Warburton

Client: CRS Performing Parties

Location: Elyria, OH

Start Date: 11/17/10

Contractor: Frontz Drilling

Finish Date: 11/17/10

Equipment: Geoprobe 6620 DT

Project No.: 139452

Method: Direct Push

SURVEY DATA

Ground:

North:

TPVC:

East:

Depth (ft)	Well Construction	Symbol	Lithologic Description	Sample				Remarks
				Run	Type	PID (ppm)	Recovery (ft)	
-2			Ground Surface					
-1			(0-0.4') Concrete base, damp					
0			(0.4-0.6') Red brick fragments					
1			(0.6-1.0') Fill- slag, dark brown, moist					
2			(1.0-1.8') Sandstone fragments, brown, moist	1	DP	5.2	2.2	
3			(1.8-2.2') Fill- dark brown, moist					
4			(4.0-4.8') Fill- dark brown, moist					
5			(4.8-5.6') Silty sandy clay, brown, moist					
6			(5.6-6.8') Silty sandy clay, sandstone fragments, brown, moist	2	DP	0.5	2.8	
7								
8			(8.0-9.0') Silty clay, occasional black slag, brown, moist, HC odor					
9			Refusal at 9.0'					
10				3	DP	41.1	1.0	
11								
12			End of Log					
13								

WELL CONSTRUCTION

Diameter (ID): 1"

Material: PVC

Coupling: NA

Hole Diameter: 3.25"

WELL DEVELOPMENT

Methods: NA

Duration: NA

Vol. Purged: NA

Slug Test: NA

Project: Chemical Recovery SystemsBC Personnel: J. Warburton

Client: CRS Performing Parties

Location: Elyria, OH

Start Date: 11/17/10

Contractor: Frontz Drilling

Finish Date: 11/17/10

Equipment: Geoprobe 6620 DT

Project No.: 139452

Method: Direct Push

SURVEY DATA

Ground:

North:

TPVC:

East:

Depth (ft)	Well Construction	Symbol	Lithologic Description	Sample				Remarks
				Run	Type	PID (ppm)	Recovery (ft)	
-2	<p>1" PVC</p> <p>Hydrated bentonite chips</p> <p>Sand</p>		Ground Surface					
-1			(0-0.2') Topsoil and gravel, brown, moist					
0			(0.2-0.6') Fill- silty clay, brown, moist					
1			(0.6-0.8') Red brick fragments					
2			(0.8-1.2') Clayey sand, sandstone fragments, brown, moist	1	DP	13.5	2.2	
3			(1.2-2.2') Clayey sand and gravel, slag, dark brown, moist					
4			(4.0-4.9') Fill- clayey sand and gravel, brown, moist					
5			(4.9-5.5') Sand and sandstone fragments, brown, damp					
6			(5.5-6.5') Clayey sand and gravel, dark brown, moist	2	DP	32.9	3.0	
7			(6.5-7.0') Clayey sand, black, moist, HC odor					
8			(8.0-8.8') Clayey sand and weathered sandstone, slightly greenish brown, sharp HC odor					
9			Refusal at 8.8'					
10				3	DP	145.9	0.8	
11								
12			End of Log					
13								

WELL CONSTRUCTION

Diameter (ID): 1"

Material: PVC

Coupling: NA

Hole Diameter: 3.25"

WELL DEVELOPMENT

Methods: NA

Duration: NA

Vol. Purged: NA

Slug Test: NA

Project: Chemical Recovery Systems BC Personnel: J. Warburton

Client: CRS Performing Parties

Location: Elyria, OH

Start Date: 11/17/10

Contractor: Frontz Drilling

Finish Date: 11/17/10

Equipment: Geoprobe 6620 DT

Project No.: 139452

Method: Direct Push

SURVEY DATA

Ground:

North:

TPVC:

East:

Depth (ft)	Well Construction	Symbol	Lithologic Description	Sample				Remarks
				Run	Type	PID (ppm)	Recovery (ft)	
-2	<p>1" PVC</p> <p>Hydrated bentonite chips</p> <p>Sand</p>		Ground Surface					
-1			(0-0.4') Topsoil and roots, brown, moist					
0			(0.1-1.1') Gravel, sand, and crushed concrete, gray, damp					
1			(1.1-1.3') Crushed brick, pink, damp					
2			(1.3-1.5') Sand, brown, damp	1	DP	65.3	2.5	
3			(1.5-1.6') Sand, black, damp					
4			(1.6-1.9') Sand, pinkish-brown, dry					
5			(1.9-2.5') Red brick fragments, dry					
6			(4.0-6.7') Silty sandy clay, some gravel, black, wet, strong HC odor	2	DP	1516	2.7	
7								
8			(8.0-8.4') Silty sandy clay, some gravel, black, wet, HC odor					
9			(8.4-8.8') Sandstone, brown, moist					
10			Refusal at 8.8'	3	DP	1167	0.8	
11								
12			End of Log					
13								

WELL CONSTRUCTION

Diameter (ID): 1"

Material: PVC

Coupling: NA

Hole Diameter: 3.25"

WELL DEVELOPMENT

Methods: NA

Duration: NA

Vol. Purged: NA

Slug Test: NA

Project: Chemical Recovery SystemsBC Personnel: J. Warburton

Client: CRS Performing Parties

Location: Elyria, OH

Start Date: 11/17/10

Contractor: Frontz Drilling

Finish Date: 11/17/10

Equipment: Geoprobe 6620 DT

Project No.: 139452

Method: Direct Push

SURVEY DATA

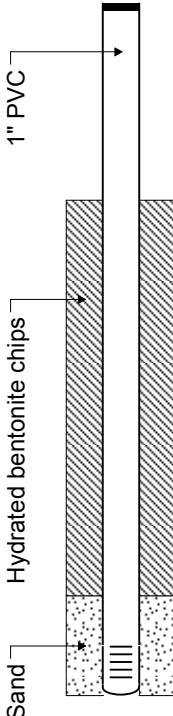
Ground:

North:

TPVC:

East:

Depth (ft)	Well Construction	Symbol	Lithologic Description	Sample				Remarks
				Run	Type	PID (ppm)	Recovery (ft)	
-2	<p>1" PVC</p> <p>Hydrated bentonite chips</p> <p>Sand</p>		Ground Surface					
-1			(0-0.2') Topsoil					
0			(0.2-2.2') Sand and gravel, dark gray, moist					
1			(2.2-2.6') Red brick fragments, damp	1	DP	327.5	3.0	
2			(2.6-3.0') Clayey sand and sandstone fragments, brown, moist					
3			(4.0-5.8') Clayey sand and sandstone fragments, dark brown, HC odor					
4				2	DP	436	1.8	
5			(8.0-8.1') Silty clay, sandstone, brown, moist, HC odor					
6			Refusal at 8.1'					
7				3	DP	93.3	0.1	
8			End of Log					
9								
10								
11								
12								
13								

<div><div><div>Brown AND Caldwell</div></div><div>4700 Lakehurst Court, Suite 100 Dublin, OH 43016</div></div>			Boring/Hole #: GP-59		Page No.: 1 of 1				
Project: Chemical Recovery SystemsBC Personnel: J. Warburton Client: CRS Performing PartiesLocation: Elyria, OH Start Date: 11/18/10Contractor: Frontz Drilling Finish Date: 11/18/10Equipment: Geoprobe 6620 DT Project No.: 139452Method: Direct Push			WELL CONSTRUCTION		WELL DEVELOPMENT				
			Diameter (ID): 1" Material: PVC Coupling: NA Hole Diameter: 3.25"		Methods: NA Duration: NA Vol. Purged: NA Slug Test: NA				
			SURVEY DATA						
			Ground:		North:				
			TPVC:		East:				
Depth (ft)	Well Construction	Symbol	Lithologic Description	Sample				Remarks	
				Run	Type	PID (ppm)	Recovery (ft)		
-2									
-1									
0				Ground Surface					
				(0-0.2') Topsoil, brown, moist					
				(0.2-0.4') Crushed concrete					
				(0.4-1.2') Red brick fragments					
1				(1.2-1.8') Sand and sandstone, light gray, damp					
2					1	DP	0.7	1.8	
3									
4									
5				(4.0-5.6') Sand and sandstone, brown, damp Refusal at 5.6'					
6					2	DP	0.0	1.6	
7									
8									
9									
10									
			End of Log						

WELL CONSTRUCTION

Diameter (ID): 1"

Material: PVC

Coupling: NA

Hole Diameter: 3.25"

WELL DEVELOPMENT

Methods: NA

Duration: NA

Vol. Purged: NA

Slug Test: NA

Project: Chemical Recovery SystemsBC Personnel: J. Warburton

Client: CRS Performing Parties

Location: Elyria, OH

Start Date: 11/18/10

Contractor: Frontz Drilling

Finish Date: 11/18/10

Equipment: Geoprobe 6620 DT

Project No.: 139452

Method: Direct Push

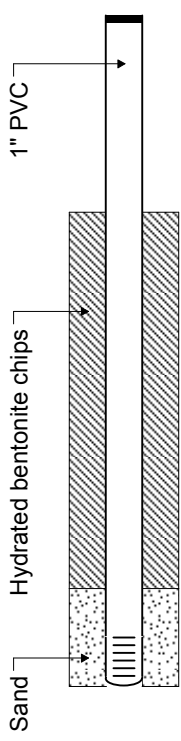
SURVEY DATA

Ground:

North:

TPVC:

East:

Depth (ft)	Well Construction	Symbol	Lithologic Description	Sample				Remarks
				Run	Type	PID (ppm)	Recovery (ft)	
-2			Ground Surface					
-1			(0-0.2') Topsoil, brown, moist					
0			0.2-1.7') Sand and sandstone, light brown, dry					
1				1	DP	0.1	1.7	
2								
3								
4			(4.0-4.8') Sand and sandstone, light brown, dry					
5			Refusal at 4.8'					
6				2	DP	NM	0.8	
7								
8			End of Log					
9								
10								

WELL CONSTRUCTION

Diameter (ID): 1"

Material: PVC

Coupling: NA

Hole Diameter: 3.25"

WELL DEVELOPMENT

Methods: NA

Duration: NA

Vol. Purged: NA

Slug Test: NA

Project: Chemical Recovery SystemsBC Personnel: J. Warburton

Client: CRS Performing Parties

Location: Elyria, OH

Start Date: 11/18/10

Contractor: Frontz Drilling

Finish Date: 11/18/10

Equipment: Geoprobe 6620 DT

Project No.: 139452

Method: Direct Push

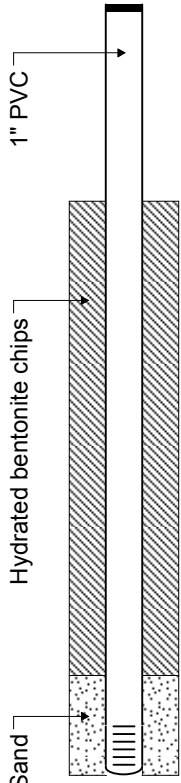
SURVEY DATA

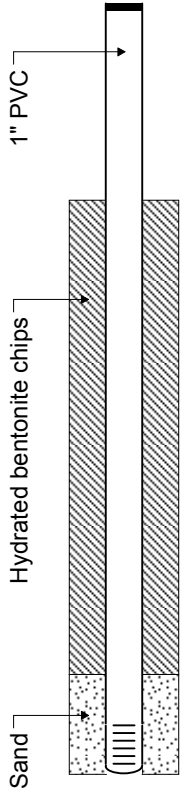
Ground:

North:

TPVC:

East:

Depth (ft)	Well Construction	Symbol	Lithologic Description	Sample				Remarks
				Run	Type	PID (ppm)	Recovery (ft)	
-2			Ground Surface					
-1			(0-0.2') Red brick fragments					
0			0.2-0.3') Silty clay, brown, moist					
1			0.3-0.8') Crushed sandstone, light brown, damp					
2				1	DP	NM	0.8	
3								
4			(4.0-5.1') Crushed sandstone, light brown, damp					
5			(5.1-6.4') Clayey sand and sandstone fragments, brown, moist					
6			Refusal at 6.4'	2	DP	0.0	2.4	
7								
8			End of Log					
9								
10								

<div><div><div>Brown AND Caldwell</div></div><div>4700 Lakehurst Court, Suite 100 Dublin, OH 43016</div></div>		<div><div>Boring/Hole #: GP-62</div><div>Page No.: 1 of 1</div></div>							
<div><div>Project: Chemical Recovery SystemsBC Personnel: J. Warburton</div><div>Client: CRS Performing PartiesLocation: Elyria, OH</div><div>Start Date: 11/18/10Contractor: Frontz Drilling</div><div>Finish Date: 11/18/10Equipment: Geoprobe 6620 DT</div><div>Project No.: 139452Method: Direct Push</div></div>		<div><div><div>WELL CONSTRUCTION</div><div>Diameter (ID): 1"</div><div>Material: PVC</div><div>Coupling: NA</div><div>Hole Diameter: 3.25"</div></div><div><div>WELL DEVELOPMENT</div><div>Methods: NA</div><div>Duration: NA</div><div>Vol. Purged: NA</div><div>Slug Test: NA</div></div></div>							
		<div><div>SURVEY DATA</div><div>Ground:</div><div>TPVC:</div><div>North:</div><div>East:</div></div>							
Depth (ft)	Well Construction	Symbol	Lithologic Description	Sample				Remarks	
				Run	Type	PID (ppm)	Recovery (ft)		
-2									
-1									
0				Ground Surface					
				(0-0.4') Topsoil, brown, moist					
				0.4-1.9') Silty clay, sandstone fragments, brown, moist					
1									
2					1	DP	0.0	1.9	
3									
4									
5				(4.0-6.4') Sand and sandstone fragments, brown, moist					
6			Refusal at 6.4'	2	DP	0.2	2.4		
7									
8									
9									
10			End of Log						

WELL CONSTRUCTION

Diameter (ID): 1"

Material: PVC

Coupling: NA

Hole Diameter: 3.25"

WELL DEVELOPMENT

Methods: NA

Duration: NA

Vol. Purged: NA

Slug Test: NA

Project: Chemical Recovery SystemsBC Personnel: J. Warburton

Client: CRS Performing Parties

Location: Elyria, OH

Start Date: 11/18/10

Contractor: Frontz Drilling

Finish Date: 11/18/10

Equipment: Geoprobe 6620 DT

Project No.: 139452

Method: Direct Push

SURVEY DATA

Ground:

North:

TPVC:

East:

Depth (ft)	Well Construction	Symbol	Lithologic Description	Sample				Remarks
				Run	Type	PID (ppm)	Recovery (ft)	
-2			Ground Surface					
-1			(0-0.6') Topsoil, moist					
0			0.4-1.1') Fill, dark brown, moist					
1			(1.1-2.2') Sandstone fragments, light brown, damp					
2				1	DP	0.2	2.2	
3								
4			(4.0-5.3') Clayey sand and sandstone, brown, moist					
5			(5.3-6.1') Sand and sandstone, light brown, damp					
6			Refusal at 6.1'	2	DP	2.1	2.1	
7								
8			End of Log					
9								
10								

WELL CONSTRUCTION

Diameter (ID): 1"

Material: PVC

Coupling: NA

Hole Diameter: 3.25"

WELL DEVELOPMENT

Methods: NA

Duration: NA

Vol. Purged: NA

Slug Test: NA

Project: Chemical Recovery Systems BC Personnel: J. Warburton

Client: CRS Performing Parties

Location: Elyria, OH

Start Date: 11/18/10

Contractor: Frontz Drilling

Finish Date: 11/18/10

Equipment: Geoprobe 6620 DT

Project No.: 139452

Method: Direct Push

SURVEY DATA

Ground:

North:

TPVC:

East:

Depth (ft)	Well Construction	Symbol	Lithologic Description	Sample				Remarks
				Run	Type	PID (ppm)	Recovery (ft)	
-2	<p>1" PVC</p> <p>Hydrated bentonite chips</p> <p>Sand</p>		Ground Surface					
-1			(0-0.2') Topsoil, brown, moist					
0			0.2-0.4') Fill, brown, moist					
1			(0.4-0.8') Red brick fragments, slight HC odor					
2			(0.8-1.3') Concrete and sandstone, damp	1	DP	7.9	1.3	
3								
4			(4.0-4.9') Sand and sandstone fragments, brown, damp					
5			Refusal at 4.9'					
6				2	DP	0.0	0.9	
7								
8			End of Log					
9								
10								

WELL CONSTRUCTION

Diameter (ID): 1"

Material: PVC

Coupling: NA

Hole Diameter: 3.25"

WELL DEVELOPMENT

Methods: NA

Duration: NA

Vol. Purged: NA

Slug Test: NA

Project: Chemical Recovery Systems BC Personnel: J. Warburton

Client: CRS Performing Parties

Location: Elyria, OH

Start Date: 11/18/10

Contractor: Frontz Drilling

Finish Date: 11/18/10

Equipment: Geoprobe 6620 DT

Project No.: 139452

Method: Direct Push

SURVEY DATA

Ground:

North:

TPVC:

East:

Depth (ft)	Well Construction	Symbol	Lithologic Description	Sample				Remarks
				Run	Type	PID (ppm)	Recovery (ft)	
-2			<p>Ground Surface</p> <p>(0-0.2') Topsoil, brown, moist</p> <p>(0.2-0.3') Silty clay, brown, moist</p> <p>(0.3-0.4') Red brick fragments</p> <p>(0.4-0.8') Silty clay, brown, moist</p> <p>(0.8-1.2') Sand, brown, moist</p>	1	DP	0.2	1.2	
-1								
0								
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
			(4.0-4.6') Sand and sandstone fragments, brown, moist	2	DP	0.1	0.6	
			Refusal at 4.6'					
			End of Log					

WELL CONSTRUCTION

Diameter (ID): 1"

Material: PVC

Coupling: NA

Hole Diameter: 3.25"

WELL DEVELOPMENT

Methods: NA

Duration: NA

Vol. Purged: NA

Slug Test: NA

Project: Chemical Recovery Systems BC Personnel: J. Warburton

Client: CRS Performing Parties

Location: Elyria, OH

Start Date: 11/18/10

Contractor: Frontz Drilling

Finish Date: 11/18/10

Equipment: Geoprobe 6620 DT

Project No.: 139452

Method: Direct Push

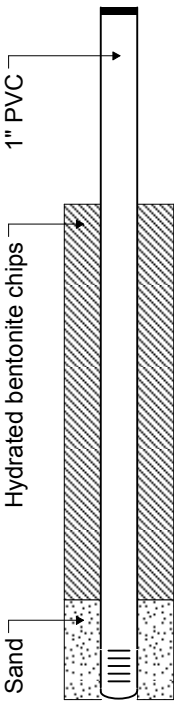
SURVEY DATA

Ground:

North:

TPVC:

East:

Depth (ft)	Well Construction	Symbol	Lithologic Description	Sample				Remarks
				Run	Type	PID (ppm)	Recovery (ft)	
-2								
-1								
0								
1								
2					1	DP	2.5	1.4
3								
4								
5					2	DP	0.0	1.2
6								
7								
8								
9								
10								

WELL CONSTRUCTION

Diameter (ID): 1"

Material: PVC

Coupling: NA

Hole Diameter: 3.25"

WELL DEVELOPMENT

Methods: NA

Duration: NA

Vol. Purged: NA

Slug Test: NA

Project: Chemical Recovery SystemsBC Personnel: J. Warburton

Client: CRS Performing Parties

Location: Elyria, OH

Start Date: 11/18/10

Contractor: Frontz Drilling

Finish Date: 11/18/10

Equipment: Geoprobe 6620 DT

Project No.: 139452

Method: Direct Push

SURVEY DATA

Ground:

North:

TPVC:

East:

Depth (ft)	Well Construction	Symbol	Lithologic Description	Sample				Remarks
				Run	Type	PID (ppm)	Recovery (ft)	
-2			Ground Surface					
-1			(0-0.2') Topsoil, brown, moist					
0			(0.2-0.3') Red brick fragments					
1			(0.3-0.8') Silty clay and fill, brown, moist					
2			(0.8-1.2') Sand and sandstone fragments, light brown, damp					
3			(1.2-1.9') Sandy silty clay, sandstone fragments, brown, moist	1	DP	0.0	1.9	
4			(4.0-4.7') Sandy silty clay, sandstone fragments, brown, moist					
5			(4.7-5.0') Clayey sand and sandstone fragments, orange-brown, moist					
6			(5.0-6.0') Sandy silty clay, brown, moist					
7			(6.0-6.5') Sandy silty clay, sandstone fragments, brown, moist	2	DP	1.0	3.0	
8			(6.5-7.0') Sandy silty clay, sandstone fragments, light brown, moist					
9			Refusal at 7.0'					
10			End of Log					

WELL CONSTRUCTION

Diameter (ID): 1"

Material: PVC

Coupling: NA

Hole Diameter: 3.25"

WELL DEVELOPMENT

Methods: NA

Duration: NA

Vol. Purged: NA

Slug Test: NA

Project: Chemical Recovery SystemsBC Personnel: J. Warburton

Client: CRS Performing Parties

Location: Elyria, OH

Start Date: 11/18/10

Contractor: Frontz Drilling

Finish Date: 11/18/10

Equipment: Geoprobe 6620 DT

Project No.: 139452

Method: Direct Push

SURVEY DATA

Ground:

North:

TPVC:

East:

Depth (ft)	Well Construction	Symbol	Lithologic Description	Sample				Remarks
				Run	Type	PID (ppm)	Recovery (ft)	
-2			Ground Surface					
-1			(0-0.2') Topsoil, brown, moist					
0			(0.2-0.8') Silty claywith gravel, brown, moist					
1			(0.8-2.0') Sand and sandstone fragments, light brown, damp					
2				1	DP	0.0	2.0	
3								
4			(4.0-4.6') Silty clay, brown, moist					
5			(4.6-6.2') Clayey sand and sandstone fragments, orange-brown, moist					
6			(6.2-7.0') Sand and sandstone fragments, brown, damp	2	DP	0.0	3.0	
7			Refusal at 7.0'					
8			End of Log					
9								
10								

WELL CONSTRUCTION

Diameter (ID): 1"

Material: PVC

Coupling: NA

Hole Diameter: 3.25"

WELL DEVELOPMENT

Methods: NA

Duration: NA

Vol. Purged: NA

Slug Test: NA

Project: Chemical Recovery SystemsBC Personnel: J. Warburton

Client: CRS Performing Parties

Location: Elyria, OH

Start Date: 11/18/10

Contractor: Frontz Drilling

Finish Date: 11/18/10

Equipment: Geoprobe 6620 DT

Project No.: 139452

Method: Direct Push

SURVEY DATA

Ground:

North:

TPVC:

East:

Depth (ft)	Well Construction	Symbol	Lithologic Description	Sample				Remarks
				Run	Type	PID (ppm)	Recovery (ft)	
-2	<p>1" PVC</p> <p>Hydrated bentonite chips</p> <p>Sand</p>		Ground Surface					
-1			(0-0.2') Topsoil, brown, moist					
0			(0.2-0.8') Clayey gravelly fill, brown, damp					
1			(0.8-0.9') Fill- black, damp					
2			(0.9-2.0') Clayey sand and sandstone fragments, light brown, damp	1	DP	0.4	2.5	
3			(2.0-2.5') Sand and sandstone fragments, brown, damp					
4			(4.0-4.1') Sandstone, brown, damp					
5			Refusal at 4.1'					
6				2	DP	NM	0.1	
7								
8			End of Log					
9								
10								

WELL CONSTRUCTION

Diameter (ID): 1"

Material: PVC

Coupling: NA

Hole Diameter: 3.25"

WELL DEVELOPMENT

Methods: NA

Duration: NA

Vol. Purged: NA

Slug Test: NA

Project: Chemical Recovery SystemsBC Personnel: J. Warburton

Client: CRS Performing Parties

Location: Elyria, OH

Start Date: 11/18/10

Contractor: Frontz Drilling

Finish Date: 11/18/10

Equipment: Geoprobe 6620 DT

Project No.: 139452

Method: Direct Push

SURVEY DATA

Ground:

North:

TPVC:

East:

Depth (ft)	Well Construction	Symbol	Lithologic Description	Sample				Remarks
				Run	Type	PID (ppm)	Recovery (ft)	
-2			Ground Surface					
-1			(0-0.2') Topsoil, moist					
0			(0.2-0.7') Crushed concrete, damp					
1			(0.7-1.2') Slag, black, damp					
2			(1.2-2.0') Silty clay and sandstone fragments, dark brown, moist	1	DP	0.0	2.8	
3			(2.0-2.8') Sandy silt clay, brown, moist					
4			(4.0-4.8') Sand and sandstone fragments, light brown, damp					
5			Refusal at 4.8'					
6				2	DP	NM	0.8	
7								
8			End of Log					
9								
10								

WELL CONSTRUCTION

Diameter (ID): 1"

Material: PVC

Coupling: NA

Hole Diameter: 3.25"

WELL DEVELOPMENT

Methods: NA

Duration: NA

Vol. Purged: NA

Slug Test: NA

Project: Chemical Recovery Systems BC Personnel: J. Warburton

Client: CRS Performing Parties

Location: Elyria, OH

Start Date: 11/18/10

Contractor: Frontz Drilling

Finish Date: 11/18/10

Equipment: Geoprobe 6620 DT

Project No.: 139452

Method: Direct Push

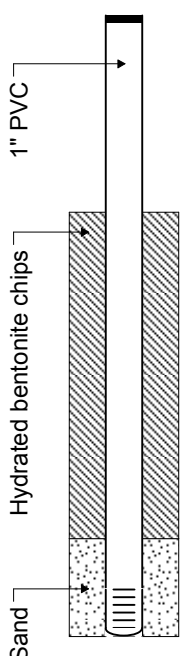
SURVEY DATA

Ground:

North:

TPVC:

East:

Depth (ft)	Well Construction	Symbol	Lithologic Description	Sample				Remarks
				Run	Type	PID (ppm)	Recovery (ft)	
-2			Ground Surface					
-1			(0-0.6') Topsoil, brown, moist					
0			(0.6-1.2') Silty clay, red brick fragments, dark brown, moist					
1			(1.2-2.0') Silty sand, orange-brown, moist					
2				1	DP	0.3	2.0	
3								
4			(4.0-4.4') Silty sand and sandstone fragments, orange-brown, moist					
5			Refusal at 4.4'					
6				2	DP	0.3	0.4	
7								
8			End of Log					
9								
10								

WELL CONSTRUCTION

Diameter (ID): 1"

Material: PVC

Coupling: NA

Hole Diameter: 3.25"

WELL DEVELOPMENT

Methods: NA

Duration: NA

Vol. Purged: NA

Slug Test: NA

Project: Chemical Recovery SystemsBC Personnel: J. Warburton

Client: CRS Performing Parties

Location: Elyria, OH

Start Date: 11/18/10

Contractor: Frontz Drilling

Finish Date: 11/18/10

Equipment: Geoprobe 6620 DT

Project No.: 139452

Method: Direct Push

SURVEY DATA

Ground:

North:

TPVC:

East:

Depth (ft)	Well Construction	Symbol	Lithologic Description	Sample				Remarks
				Run	Type	PID (ppm)	Recovery (ft)	
-2	<p>1" PVC</p> <p>Hydrated bentonite chips</p> <p>Sand</p>		Ground Surface					
-1			(0-0.6') Topsoil, brown, moist					
0			(0.6-1.0') Gravelly clay, dark brown, moist					
1			(1.0-1.2') Red brick fragments, damp					
2			(1.2-1.8') Silty clay with sand and sandstone fragments, dark brown, moist	1	DP	0.3	1.8	
3								
4			(4.0-6.1') Sand and sandstone fragments, orange-brown, moist					
5			Refusal at 6.1'					
6				2	DP	1.2	2.1	
7								
8			End of Log					
9								
10								

WELL CONSTRUCTION

Diameter (ID): 1"

Material: PVC

Coupling: NA

Hole Diameter: 3.25"

WELL DEVELOPMENT

Methods: NA

Duration: NA

Vol. Purged: NA

Slug Test: NA

Project: Chemical Recovery SystemsBC Personnel: J. Warburton

Client: CRS Performing Parties

Location: Elyria, OH

Start Date: 11/18/10

Contractor: Frontz Drilling

Finish Date: 11/18/10

Equipment: Geoprobe 6620 DT

Project No.: 139452

Method: Direct Push

SURVEY DATA

Ground:

North:

TPVC:

East:

Depth (ft)	Well Construction	Symbol	Lithologic Description	Sample				Remarks
				Run	Type	PID (ppm)	Recovery (ft)	
-2	<p>1" PVC</p> <p>Hydrated bentonite chips</p> <p>Sand</p>		Ground Surface					
-1			(0-0.2') Topsoil, brown, moist					
0			(0.2-1.8') Silty clay, slag, sandstone fragments, dark brown, moist					
1								
2				1	DP	7.2	1.8	
3								
4								
5			(4.0-7.0') Sandy clay, sandstone fragments, light brown to orange-brown, moist					
6				2	DP	1.0	3.2	
7			(7.0-7.1') Silty clay, brown, moist (7.1-7.2') Sandstone, brown, moist					
8			Refusal at 7.2'					
9			End of Log					
10								

WELL CONSTRUCTION

Diameter (ID): 1"

Material: PVC

Coupling: NA

Hole Diameter: 3.25"

WELL DEVELOPMENT

Methods: NA

Duration: NA

Vol. Purged: NA

Slug Test: NA

Project: Chemical Recovery SystemsBC Personnel: J. Warburton

Client: CRS Performing Parties

Location: Elyria, OH

Start Date: 11/18/10

Contractor: Frontz Drilling

Finish Date: 11/18/10

Equipment: Geoprobe 6620 DT

Project No.: 139452

Method: Direct Push

SURVEY DATA

Ground:

North:

TPVC:

East:

Depth (ft)	Well Construction	Symbol	Lithologic Description	Sample				Remarks
				Run	Type	PID (ppm)	Recovery (ft)	
-2			Ground Surface					
-1			(0-2.0') Silty clay, cinders, sandstone fragments, interbedded, moist	1	DP	4.2	2.0	
0								
1								
2								
3								
4			(4.0-4.3') Sandstone fragments, brown, damp	2	DP	79.7	2.3	
5			(4.3-4.5') Silty clay, brown, moist					
6			(4.5-4.7') Sand and sandstone fragments, brown, moist					
7			(4.7-5.4') Silty clay, brown, moist					
8			(5.4-6.3') Silty clay, grayish-brown					
9			(8.0-10.5') Silty clay, grayish-brown, moist	3	DP	NM	2.5	
10								
11								
12			(12.0-14.8') Silty clay, grayish-brown, moist	4	DP	1036	2.6	
13								
14								
15								
16			(16.0-16.9') Silty clay, grayish-brown, with reddish brown NAPL	5	DP	NM	0.9	
17			Refusal at 16.9'					
18								
19								
20			End of Log					

WELL CONSTRUCTION

Diameter (ID): 1"

Material: PVC

Coupling: NA

Hole Diameter: 3.25"

WELL DEVELOPMENT

Methods: NA

Duration: NA

Vol. Purged: NA

Slug Test: NA

Project: Chemical Recovery Systems BC Personnel: J. Warburton

Client: CRS Performing Parties

Location: Elyria, OH

Start Date: 11/18/10

Contractor: Frontz Drilling

Finish Date: 11/18/10

Equipment: Geoprobe 6620 DT

Project No.: 139452

Method: Direct Push

SURVEY DATA

Ground:

North:

TPVC:

East:

Depth (ft)	Well Construction	Symbol	Lithologic Description	Sample				Remarks
				Run	Type	PID (ppm)	Recovery (ft)	
-2	<p>1" PVC</p> <p>Hydrated bentonite chips</p> <p>Sand</p>		Ground Surface					
0			(0-0.2') Topsoil, brown, moist					
1			(0.2-0.8') Silty clay, cinders, brown, moist					
2			(0.8-1.4') Silty clay, brown, moist					
3			(1.4-2.1') Sand and sandstone fragments, brown, moist	1	DP	NM	2.1	
4								
5			(4.0-6.0') Sandy silty clay, brown, moist					
6			(6.0-6.8') Sandy silty clay, gray, moist, HC odor	2	DP	31.6	2.8	
7								
8			(8.0-9.0') Sandy silty clay with sandstone fragments, gray, moist, HC odor					
9			Refusal at 9.1'					
10				3	DP	765.3	1.0	
11								
12			End of Log					
13								

WELL CONSTRUCTION

Diameter (ID): 1"

Material: PVC

Coupling: NA

Hole Diameter: 3.25"

WELL DEVELOPMENT

Methods: NA

Duration: NA

Vol. Purged: NA

Slug Test: NA

Project: Chemical Recovery SystemsBC Personnel: J. Warburton

Client: CRS Performing Parties

Location: Elyria, OH

Start Date: 11/18/10

Contractor: Frontz Drilling

Finish Date: 11/18/10

Equipment: Geoprobe 6620 DT

Project No.: 139452

Method: Direct Push

SURVEY DATA

Ground:

North:

TPVC:

East:

Depth (ft)	Well Construction	Symbol	Lithologic Description	Sample				Remarks
				Run	Type	PID (ppm)	Recovery (ft)	
-2	<p>1" PVC</p> <p>Hydrated bentonite chips</p> <p>Sand</p>		Ground Surface					
-1			(0-0.2') Topsoil, brown, moist					
0			(0.2-1.3') Sand and sandstone fragments, light brown, moist					
1								
2				1	DP	2.7	1.3	
3								
4			(4.0-4.8') Clayey sand and sandstone fragments, brown, moist					
5			(4.8-6.5') Clayey sand and sandstone fragments, light brown, moist					
6				2	DP	NM	2.7	
7			(6.5-6.7') Sand and sandstone fragments, light brown, moist					
8			Refusal at 6.9'					
9			End of Log					
10								

WELL CONSTRUCTION

Diameter (ID): 1"

Material: PVC

Coupling: NA

Hole Diameter: 3.25"

WELL DEVELOPMENT

Methods: NA

Duration: NA

Vol. Purged: NA

Slug Test: NA

Project: Chemical Recovery Systems BC Personnel: J. Warburton

Client: CRS Performing Parties

Location: Elyria, OH

Start Date: 11/19/10

Contractor: Frontz Drilling

Finish Date: 11/19/10

Equipment: Geoprobe 6620 DT

Project No.: 139452

Method: Direct Push

SURVEY DATA

Ground:

North:

TPVC:

East:

Depth (ft)	Well Construction	Symbol	Lithologic Description	Sample				Remarks
				Run	Type	PID (ppm)	Recovery (ft)	
-2	<p>1" PVC</p> <p>Hydrated bentonite chips</p> <p>Sand</p>		Ground Surface					
-1			(0-0.8') Fill, dark brown, damp					
0			(0.8-1.4') Silty sand, dark brown, moist					
1			(1.4-1.9') Crushed concrete, damp	1	DP	1.5	2.5	
2			(1.9-2.5') Red brick fragments					
3			(4.0-5.0') Interbedded mixed fill					
4				2	DP	2.1	1.0	
5								
6								
7								
8			(8.0-9.0') Silty clay, cinders, gravel, wet					
9				3	DP	7.5	1.0	
10								
11								
12			(12.0-13.2') Silty clay, cinders, gravel, wet, HC odor					
13			Refusal at 16.0'	4	DP	738.3	1.2	
14								
15								
16								
17			End of Log					

WELL CONSTRUCTION

Diameter (ID): 1"

Material: PVC

Coupling: NA

Hole Diameter: 3.25"

WELL DEVELOPMENT

Methods: NA

Duration: NA

Vol. Purged: NA

Slug Test: NA

Project: Chemical Recovery Systems BC Personnel: J. Warburton

Client: CRS Performing Parties

Location: Elyria, OH

Start Date: 11/19/10

Contractor: Frontz Drilling

Finish Date: 11/19/10

Equipment: Geoprobe 6620 DT

Project No.: 139452

Method: Direct Push

SURVEY DATA

Ground:

North:

TPVC:

East:

Depth (ft)	Well Construction	Symbol	Lithologic Description	Sample				Remarks
				Run	Type	PID (ppm)	Recovery (ft)	
-2			Ground Surface					
0			(0-2.4') Clayey gravel, sand, slag, dark brown, wet	1	DP	0.8	2.4	
1								
2								
3								
4			(4.0-5.8') Clayey gravel, sand, slag, dark brown, wet	2	DP	9.3	1.8	
5								
6								
7								
8								
9			(8.0-8.8') Crushed sandstone, brown, moist	3	DP	2.3	0.8	
10								
11								
12			(12-12.5') Clayey gravel, sand, slag, dark brown, wet, HC odor	4	DP	173.4	0.5	
13			Refusal at 16.0'					
14								
15								
16								
17			End of Log					

WELL CONSTRUCTION

Diameter (ID): 1"

Material: PVC

Coupling: NA

Hole Diameter: 3.25"

WELL DEVELOPMENT

Methods: NA

Duration: NA

Vol. Purged: NA

Slug Test: NA

Project: Chemical Recovery Systems BC Personnel: J. Warburton

Client: CRS Performing Parties

Location: Elyria, OH

Start Date: 11/19/10

Contractor: Frontz Drilling

Finish Date: 11/19/10

Equipment: Geoprobe 6620 DT

Project No.: 139452

Method: Direct Push

SURVEY DATA

Ground:

North:

TPVC:

East:

Depth (ft)	Well Construction	Symbol	Lithologic Description	Sample				Remarks
				Run	Type	PID (ppm)	Recovery (ft)	
-2			Ground Surface					
-1			(0-0.3') Topsoil, brown, moist					
0			(0.3-1.7') Clayey sand, gravel, slag, dark brown, moist					
1			(1.7-2.2') White substance, unknown	1	DP	4.8	3.0	
2			(2.2-2.6') Clayey sand, gravel, slag, dark brown, moist					
3			(2.6-3.0') Clayey sand, gravel, slag, with sandstone fragments, dark brown, moist					
4			(4.0-4.4') Clayey gravel, sand, slag, dark brown, moist					
5			(4.4-4.8') Red brick fragments					
6			(4.8-5.0') Sandstone fragments, light brown, damp	2	DP	0.1	1.0	
7								
8			(8.0-9.0') Silty clay, gravel, slag, brown, wet					
9								
10				3	DP	2.8	1.0	
11								
12			(12.0-12.9') Silty clay, gravel, slag, black, wet					
13			(12.9-13.2') Clayey sand and sandstone, light brown, HC odor					
14			Refusal at 15.9'	4	DP	655	1.2	
15								
16								
17			End of Log					

WELL CONSTRUCTION

Diameter (ID): 1"

Material: PVC

Coupling: NA

Hole Diameter: 3.25"

WELL DEVELOPMENT

Methods: NA

Duration: NA

Vol. Purged: NA

Slug Test: NA

Project: Chemical Recovery SystemsBC Personnel: J. Warburton

Client: CRS Performing Parties

Location: Elyria, OH

Start Date: 11/19/10

Contractor: Frontz Drilling

Finish Date: 11/19/10

Equipment: Geoprobe 6620 DT

Project No.: 139452

Method: Direct Push

SURVEY DATA

Ground:

North:

TPVC:

East:

Depth (ft)	Well Construction	Symbol	Lithologic Description	Sample				Remarks
				Run	Type	PID (ppm)	Recovery (ft)	
-2			Ground Surface					
-1			(0-0.2') Topsoil, brown, damp					
0			(0.2-1.0') Silty clay, gravel, slag, sandstone fragments, brown, moist					
1			(1.0-1.2') Red brick fragments					
2			(1.2-2.4') Silty clay, gravel, slag, sandstone fragments, brown, moist	1	DP	24.0	2.4	
3								
4			(4.0-5.0') Silty clay, gravel, slag, sandstone fragments, dark brown, moist					
5								
6				2	DP	2.9	1.0	
7								
8								
9			(8.0-9.0') Silty clay, gravel, slag, sandstone fragments, dark brown, wet					
10				3	DP	10.5	1.0	
11								
12			(12.0-12.7') Silty clay, gravel, slag, sandstone fragments, dark brown, wet					
13			(12.7-13.2') Sandstone and sand, brown, wet					
14			(13.2-13.4') Silty clay, brown, moist, gasoline odor	4	DP	328.3	1.4	
15			Refusal at 15.4'					
16			End of Log					
17								

WELL CONSTRUCTION

Diameter (ID): 1"

Material: PVC

Coupling: NA

Hole Diameter: 3.25"

WELL DEVELOPMENT

Methods: NA

Duration: NA

Vol. Purged: NA

Slug Test: NA

Project: Chemical Recovery SystemsBC Personnel: J. Warburton

Client: CRS Performing Parties

Location: Elyria, OH

Start Date: 11/19/10

Contractor: Frontz Drilling

Finish Date: 11/19/10

Equipment: Geoprobe 6620 DT

Project No.: 139452

Method: Direct Push

SURVEY DATA

Ground:

North:

TPVC:

East:

Depth (ft)	Well Construction	Symbol	Lithologic Description	Sample				Remarks
				Run	Type	PID (ppm)	Recovery (ft)	
-2	<p>1" PVC</p> <p>Hydrated bentonite chips</p> <p>Sand</p>		Ground Surface					
-1			(0-0.1') Topsoil, brown, damp					
0			(0.1-1.0') Fill- cinders, glass, gravel, dark brown, moist					
1			(1.0-1.3') Sand and sandstone, brown, moist	1	DP	5.8	1.9	
2			(1.3-1.5') Fill- cinders, glass, gravel, dark brown, moist					
3			(1.5-1.9') Sand and sandstone, light brown, moist					
4			(4.0-4.9') Fill- cinders, glass, gravel, dark brown, moist	2	DP	7.0	0.9	
5								
6								
7								
8			(8.0-9.1') Clayey gravel and slag, brown, moist to wet					
9								
10				3	DP	62.6	1.1	
11								
12			(12.0-13.0') Clayey gravel and slag, brown, wet, HC odor					
13			(13.0-13.4') Silty clay, little f. gravel, gray, moist, HC odor	4	DP	1123	1.4	
14								
15			(16.0-16.3') Silty clay, moist, HC odor					
16			Refusal at 16.3'	5	DP	NM	0.3	
17								
18								
19								
20			End of Log					

WELL CONSTRUCTION

Diameter (ID): 1"

Material: PVC

Coupling: NA

Hole Diameter: 3.25"

WELL DEVELOPMENT

Methods: NA

Duration: NA

Vol. Purged: NA

Slug Test: NA

Project: Chemical Recovery SystemsBC Personnel: J. Warburton

Client: CRS Performing Parties

Location: Elyria, OH

Start Date: 11/19/10

Contractor: Frontz Drilling

Finish Date: 11/19/10

Equipment: Geoprobe 6620 DT

Project No.: 139452

Method: Direct Push

SURVEY DATA

Ground:

North:

TPVC:

East:

Depth (ft)	Well Construction	Symbol	Lithologic Description	Sample				Remarks
				Run	Type	PID (ppm)	Recovery (ft)	
-2			Ground Surface					
-1			(0-3.0') Mixed fill, damp					
0				1	DP	13.6	3.0	
1								
2								
3								
4			(4.0-5.2') Mixed fill, damp					
5								
6				2	DP	183.7	1.2	
7								
8								
9			(8.0-9.2') Mixed fill, wet at 9.2'					
10				3	DP	18.9	1.2	
11								
12			(12.0-13.2') Mixed fill, wet, HC odor					
13			Refusal at 16.0'	4	DP	402.2	1.2	
14								
15								
16								
17			End of Log					

WELL CONSTRUCTION

Diameter (ID): 1"

Material: PVC

Coupling: NA

Hole Diameter: 3.25"

WELL DEVELOPMENT

Methods: NA

Duration: NA

Vol. Purged: NA

Slug Test: NA

Project: Chemical Recovery Systems BC Personnel: J. Warburton

Client: CRS Performing Parties

Location: Elyria, OH

Start Date: 11/19/10

Contractor: Frontz Drilling

Finish Date: 11/19/10

Equipment: Geoprobe 6620 DT

Project No.: 139452

Method: Direct Push

SURVEY DATA


Ground:

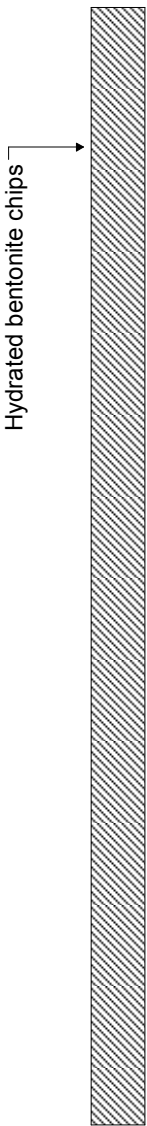


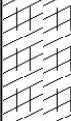
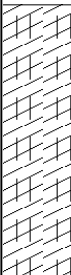


North:

TPVC:

East:

Depth (ft)	Well Construction	Symbol	Lithologic Description	Sample				Remarks
				Run	Type	PID (ppm)	Recovery (ft)	
-2	<p>1" PVC</p> <p>Hydrated bentonite chips</p> <p>Sand</p>		Ground Surface					
-1			(0-0.2') Topsoil, brown, moist					
0			(0.2-0.8') Gray slag, damp					
1			(0.8-1.2') Red brick fragments, damp					
2			(1.2-1.5') Black slag, damp	1	DP	3.8	3.3	
3			(1.5-2.2') Sandstone fragments, light brown, moist					
4			(2.2-3.3') Fill- cinders, gravel, glass, black, moist					
5			(4.0-4.8') Red brick fragments, damp					
6			(4.8-5.1') silty sand, dark brown, wet	2	DP	7.7	2.4	
7			(5.1-5.7') Sand and sandstone fragments, yellowish brown, moist					
8			(5.7-6.4') Sand and sandstone fragments, gray, moist					
9			(8.0-8.8') Sand and sandstone fragments, gray, moist					
10				3	DP	10.7	0.8	
11								
12			(12.0-12.2') Fill- black, wet					
13			Refusal at 16.2'					
14				4	DP	107.3	0.2	
15								
16								
17			End of Log					
18								
19								
20								

 <div> 4700 Lakehurst Court, Suite 100 Dublin, OH 43016 </div>			Boring/Hole #: GP-84 <div> WELL CONSTRUCTION Diameter (ID): 1" Material: PVC Coupling: NA Hole Diameter: 3.25" </div>		Page No.: 1 of 1 <div> WELL DEVELOPMENT Methods: NA Duration: NA Vol. Purged: NA Slug Test: NA </div>	
Project: Chemical Recovery Systems Client: CRS Performing Parties Start Date: 11/19/10 Finish Date: 11/19/10 Project No.: 139452			BC Personnel: J. Warburton Location: Elyria, OH Contractor: Frontz Drilling Equipment: Geoprobe 6620 DT Method: Direct Push			
			SURVEY DATA Ground: TPVC:			
			North: East:			

Depth (ft)	Well Construction	Symbol	Lithologic Description	Sample				Remarks
				Run	Type	PID (ppm)	Recovery (ft)	
0			Ground Surface					
0.5			(0-0.5') Fill, brown, damp					
0.5			(0.5-3.5') Silty clay, brown, moist					
1								
2				1	DP	4.5	3.5	
3								
4								
5			(4.0-8.0') Silty clay, brown, moist, becoming gray and soft at 5.8'					
6								
7								
8		(8.0-12.0') Silty clay, grayish brown to gray, moist, slight HC odor						
9								
10								
11								
12		(12.0-16.0') Silty clay, gray, NAPL in thin sand seam at 15.6'						
13								
14			Refusal at 16.0'					
15								
16								
17			End of Log					

<div><div><div>Brown AND Caldwell</div></div><div>4700 Lakehurst Court, Suite 100 Dublin, OH 43016</div></div>			<div>Boring/Hole #: GP-85Page No.: 1 of 1</div> <div><div>WELL CONSTRUCTION</div><div>Diameter (ID): 1" Material: PVC Coupling: NA Hole Diameter: 3.25"</div></div> <div><div>WELL DEVELOPMENT</div><div>Methods: NA Duration: NA Vol. Purged: NA Slug Test: NA</div></div>					
<div>Project: Chemical Recovery SystemsBC Personnel: J. Warburton</div> <div>Client: CRS Performing PartiesLocation: Elyria, OH</div> <div>Start Date: 11/19/10Contractor: Frontz Drilling</div> <div>Finish Date: 11/19/10Equipment: Geoprobe 6620 DT</div> <div>Project No.: 139452Method: Direct Push</div>			<div>SURVEY DATA</div> <div>Ground:North:</div> <div>TPVC:East:</div>					
Depth (ft)	Well Construction	Symbol	Lithologic Description	Sample				Remarks
				Run	Type	PID (ppm)	Recovery (ft)	
0	<div>Hydrated bentonite chips</div> <div></div>		Ground Surface					
0-1.5'		(0-1.5') Cinders, black, damp						
1								
2		(1.5-2.0') Sandstone and sand, yellowish brown, moist	1	DP	6.1	2.0		
3								
4								
5		(4.0-6.0') Silty sand, occasional sandstone fragments, yellow, wet						
6		(6.0-6.5') Sandstone fragments and sand, yellowish brown, moist	2	DP	1.7	2.5		
7								
8		(8.0-8.5') Sandstone fragments and sand, yellowish brown, wet						
9	Refusal at 8.5'							
10				3	DP	0.9	0.5	
11								
12			End of Log					
13								



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

REGION 5

77 WEST JACKSON BOULEVARD
CHICAGO, IL 60604-3590

REPLY TO THE ATTENTION OF: SR-6J

June 16, 2011

Mr. Patrick Steerman
Steerman Environmental Management & Consulting, LLC
422 Creek View Lane
Roswell, GA 30075

Re: Chemical Recovery Systems Inc. Site
Additional Groundwater Studies Work Plan Approval

Dear Mr. Steerman:

On March 31, 2011, the U.S. Environmental Protection Agency (EPA) and Ohio Environmental Protection Agency (OEPA) received the additional groundwater studies work plan, from Mr. James Peeples of Brown and Caldwell, representing the Chemical Recovery Systems Remedial Design/Remedial Action Group Performing Parties (CRS Group). The Agencies commented on the work plan on April 25, 2011, and CRS Group responded to those comments June 3, 2011. The CRS Group, EPA, and OEPA held a conference call to discuss the plan and comments on May 3, 2011. A final revised work plan was received on June 16, 2011. EPA accepts the revised Additional Groundwater Studies work plan as submitted June 16, 2011.

If you have any questions or concerns, please contact me at (312) 886-8961.

Sincerely,

A handwritten signature in black ink, reading "Michelle Kerr".

Michelle Kerr
Remedial Project Manager

cc via email: L. Antonelli, OEPA
L. Mencin, Sherwin Williams
J. Peeples, B&C



via electronic transfer and overnight mail

October 9, 2012

Michelle Kerr
Remedial Project Manager
U.S EPA – Region 5
77 W. Jackson Blvd.
Mail Code: S-6J
Chicago, IL 60604-3590

**Re: Submittal of Additional Groundwater Studies Report
United States of America v. AK Steel Corporation et. al.
Case No. 1:10-cv-00996-KMO
Chemical Recovery Systems Site, Elyria, Ohio**

Dear Ms. Kerr:

Pursuant to the above-referenced Consent Decree, Steerman Environmental Management & Consulting is submitting the enclosed Additional Ground Water Studies report on behalf of the Settling Performing Defendants in the Chemical Recovery Systems, Inc. Site RD/RA Group.

If you have any questions regarding the report, please feel free to contact the undersigned at (770) 992-2836, or by electronic message to psteerman@charter.net.

Best Regards,

Patrick S. Steerman
CRS Site Project Coordinator

cc: Larry Antonelli, Ohio EPA
Nigel Goulding, EHS Support (electronic)
Richard Karl, Director Superfund, EPA Region 5 (transmittal)
Doug McWilliams, CRS RD/RA Group Counsel
Larry Mencin, CRS RD/RA Group (electronic)
Thomas Nash, Esq. – U.S. EPA (transmittal)
Mike Watkins, Brown & Caldwell (transmittal)



Steerman Environmental
Management & Consulting, LLC
422 Creek View Lane
Roswell, Georgia 30075
(404) 421-3275 - Voice
psteerman@charter.net



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 5
77 WEST JACKSON BOULEVARD
CHICAGO, IL 60604-3590

SR-6J

November 15, 2012

REPLY TO THE ATTENTION OF:

Mr. Patrick Steerman
Steerman Environmental Management & Consulting, LLC
422 Creek View Lane
Roswell, GA 30075

Re: Chemical Recovery Systems Inc. Site
Comments on Additional Groundwater Studies Report

Dear Mr. Steerman:

On October 9, 2012, the U.S. Environmental Protection Agency (EPA) and Ohio Environmental Protection Agency (OEPA) received the additional groundwater studies report (AGWS) from Steerman Environmental Management & Consulting, representing the Chemical Recovery Systems Remedial Design/Remedial Action Group Performing Parties. Following are questions and comments from the Agencies on the plan.

The agencies generally believe the characterization efforts have documented the current conditions as they relate to historical site operations. We are in agreement with the conceptual site model (CSM) outlined the AGWS with the exception of whether all of the site-impacted groundwater discharges into the river. The vertical extent of groundwater contamination is not defined and flow at depth is not discussed. The Group needs to address this. While the rest of the comments are numerous, the majority are minor corrections or requests for further details and/or clarification.

1. Executive Summary, Page ES-2, First Paragraph and Section 4, Hydrogeologic Conceptual Site Model, Page 4-1, Second Paragraph
It is data that demonstrates and verifies conclusions which are incorporated into the CSM. The CSM simply summarizes what is known and assumed (or suspected) about the site.
2. Investigative and Remedial History, Section 2.2
Absent from this history is any mention of the Record of Decision and the Consent Decree Statement of Work that provided the basis for undertaking the investigations that began in 2010. Please revise.
3. Monitoring Well Installation, Section 3.2.1
 - a. The last bullet states "...the CSM clearly indicates that groundwater from the site discharges to the River ...". This is a circular argument. The CSM summarizes the conclusion of the AGWS. It is results of the AGWS that indicate (or demonstrate) that groundwater from the site discharges to the River.
 - b. The last bullet states "... groundwater from the site discharges to the River from both sides of the River". It is a minor misstatement to say that site groundwater discharges

to the River from both sides of the river. Site groundwater discharges to the River on the east side of the river; groundwater on the west side of the river discharges to the river on the west side. Please revise.

- c. Please provide some explanation regarding the method of well development (airlift) used. Why was airlift used rather than surging and bailing? While the work plan does allow well development via airlift, it states that "in general most wells will be developed by using surge block and bailing". The work plan only describes development by using surge block and bailing in detail.
 - d. Please provide rationale for the well depths and open borehole lengths of the new monitoring wells. Monitoring wells constructed during the remedial investigation have lengths of ten feet; several of the new monitoring wells constructed as part of the AGWS had substantially longer lengths (MW-10A at 22 feet, MW-12 at 30.5 feet, MW-15A at 19 feet, MW-15B at 15 feet). It is unclear why the longer lengths were used. If any vertical gradients are present, longer screens also allow cross-contamination as contaminants redistribute over the length of the screen due to vertical borehole flow. If vertical gradients are present, water levels measured in wells with longer screen lengths (e.g., greater than ten feet) are potentially ambiguous due to vertical flow in the borehole. Ideally, vertical gradients should be based on water levels measured in wells with short screens.
4. Downhole Geophysical Logging, Section 3.2.6, Page 3-5
Mention is made of the heat-pulse flowmeter being used. Where are the results of this testing? Did this testing provide any useful information?
 5. Section 3.3.4, Permeability Testing of Bedrock and Appendix J
Please explain the significance of the yellow highlighted values in the table of packer test results in Appendix J.
 6. Section 4, Hydrogeologic Conceptual Site Model, Page 4-1, Bullet #1
It is stated that the base of the River extends some 15 feet below the elevation of groundwater on the site. This is inaccurate. Perhaps the authors meant that the base of the River is below the level of the potentiometric surface of the groundwater at the site. There certainly is groundwater at the site found at depths lower than the base of the river. Please revise or clarify.
 7. Section 4, Hydrogeologic Conceptual Site Model, Page 4-1, Bullet #3
It is concluded that groundwater discharges to the River. We agree with the conclusion that groundwater under the site discharges to the river. But it is unknown if all of the groundwater underneath the site discharges to the River, since groundwater extends much deeper than was investigated. It is common for deeper groundwater near a small river to underflow the river, moving consistent with the regional groundwater flow pattern even as the shallower groundwater is discharging into the river. To conclude that all groundwater discharges to the river, deeper horizons would need to have been investigated. Given the conceptualization (stated in the first paragraph of Section 4.1.3) that horizontal groundwater flow is predominantly controlled by laterally extensive bedding plane fractures, it is unclear what would be the mechanism for upward vertical flow of groundwater located in the

bedrock at elevations lower than the base of the river. A more accurate (and nuanced) conclusion is that groundwater in the upper portion of the bedrock discharges to the River (and that most contamination is found in the upper portions of the bedrock). Discuss and revise.

8. Section 4.1.2, Groundwater Elevation and Flow, Page 4-2
 - a. Please provide some discussion of regional groundwater flow.
 - b. Discussion of the separation of the investigated bedrock into two zones, the Upper Bedrock Zone and the Lower Bedrock Zone (LBZ), would be facilitated by a reference to Table 4-2, which shows the zone each well has been assigned. According to the text, the LBZ is monitored by wells with screened intervals below 667 ft., msl. According to Table 4-2, MW-15B is classified as LBZ, but is screened from 679.8 ft., msl to 664.9 ft., msl. Only 2.1 feet of the 15 foot screened interval is below 667 ft., msl. Please explain.
9. Section 4.1.2, Groundwater Elevation and Flow, Page 4-3
 - a. Of the four rounds of water levels obtained, two were collected less than a week apart in time (6/14/12 and 6/19/12). What was the rationale for collecting water levels less than a week apart?
 - b. Mention is made of downhole geophysical logging and it is stated that the logs are summarized in Table 4-1. Were any general conclusions drawn from the logging? Please summarize relevant conclusions in the text. Section 4.1.3 alludes to potential water bearing fractures identified on the geophysical logs.
 - c. Did the heat-pulse flowmeter testing provide any insights?
 - d. Mention is made of hydraulic conductivity packer testing and it is stated that the results are summarized in Table 4-3. Please add a reference to Section 4.1.3, which discusses the results.
10. Section 4.1.2, Groundwater Elevation and Flow, Page 4-4
 - a. In the first bullet, it is stated that there is a distinct downward gradient across most of the site with the gradient decreasing as the River is approached. On what is this conclusion based? There are five well nests at which vertical gradients can be determined; please provide a table listing the calculated gradients to help support the stated conclusion.
 - b. Please acknowledge that in some cases water levels were measured in monitoring wells with long (greater than ten feet) screened intervals. Monitoring wells with long screen intervals may have vertical mixing due to flow in the borehole, resulting in ambiguous water level measurements.
 - c. In the fifth bullet, it is stated that water levels in the wells responded more slowly and gradually to rain events. More slowly than what, the River, the storm sewer, etc.?
 - d. In the sixth bullet the River elevation levels are discussed. Consider if this discussion is a better fit in Section 4.2, River Stage.
11. Section 4.1.3, Aquifer Transmissivity and Groundwater Flux
 - a. It is implied that the fractured bedrock system at this site behaves as a porous media equivalent. What is the basis for this assumption? How frequent are the horizontal

- bedding planes? Is this an equivalent porous system or a dual porosity system?
- b. Needed is a clear and consistent conceptualization of the flow regime at the site. The text implies that the horizontal flow at the site is predominantly controlled by laterally extensive bedding plane fractures. The slides prepared for the 11/8/12 teleconference/meeting included a slide "Hydro-Geological Conceptual Site Model" (#5) that includes the statement that Groundwater flow is "primarily through the inter-granular porosity of the rock". Please discuss.
 - c. During the Data Review teleconference/meeting on 9/17/12, a distinction was made (slide #13) between hydraulic conductivity in the unfractured rock (i.e. due to primary porosity of the massive bedrock) and the hydraulic conductivity of the bedding fracture zones. This conclusion was not articulated in the AGWS. Was this a conclusion of the packer testing and logging (and should be added to the AGWS) or did further analysis negate this conclusion?
12. Section 4.2, River Stage
Reference is made to "Site-specific River elevations shown on the hydrographs". Please explicitly cite the relevant figure(s).
13. Section 5.1.1, NAPL Distribution and Occurrence and Table 5-1
- a. Please explain in the text (if correct), that if there is not mention of a well/borehole in Table 5-1, that there were no observations related to non-aqueous phase liquid (NAPL, perhaps even explicitly listing the wells/boreholes with no evidence of NAPLs).
 - b. Elevated soil vapor concentrations may be indicative of dense non-aqueous phase liquid (DNAPL). What is the basis/rationale for assuming that a greater than 100 ppmv soil vapor reading is indicative of DNAPL?
14. Section 5.2, Groundwater Quality Summary, Page 5-9, Last paragraph
The text states that U.S. EPA guidance has indicated that groundwater with concentrations of 1% of the effective solubility of a compound (the 1% rule) may be indicative of a NAPL source. To be clear, the "1% rule" indicates that the groundwater sampled may have come in contact with the NAPL at some point; it is not definitive regarding distance to the NAPL. Thus, it is indicative of NAPL somewhere upgradient of the groundwater sampled. Please clarify.
15. Section 5.2, Groundwater Quality Summary, Page 5-10, Second Paragraph
MW-6RA, MW-6RB, MW-6RC were intended to evaluate vertical distribution of contaminants at MW-6. This demonstration would have been more effective had the screened lengths of MW-6RA and MW-6RB not overlapped. It is stated that that MW-6RA and MW-6RB are screened at higher elevations than MW-6. This is true by mere inches. MW-6 is screened from 700.2 ft., msl to 690.2 ft., msl. MW-6RA is screened from 700.9 ft., msl to 695.9 ft., msl. This is basically the top half of MW-6's screen (the top of MW-6RA's screen is only 0.7 feet higher than MW-6). MW-6RB is screened from 700.5 ft., msl to 691.5 ft., msl. This is nearly identical to MW-6; the top of screen is 0.3 feet higher and the bottom of the screen is 1.3 feet higher than MW-6. It is likely that the higher levels detected in MW-6 compared to MW-6RB are more indicative of lateral variability rather than vertical variability of contaminant concentrations. Please discuss.

16. Section 5.2, Groundwater Quality Summary, Page 5-10, Second Bullet

It is stated that the NAPL is the primary source of groundwater impacts. This may be true for BTEX (Benzene, Toluene, Ethylbenzene and Toluene), MAHs (Mono-Cyclic Aromatic Hydrocarbons), and PAHs (Poly-Cyclic Aromatic Hydrocarbons). It seems less true for CVOCs (Chlorinated Volatile Organic Compounds). According to Section 5.1.5.1, the compounds detected in the NAPLs were primarily MAHs and PAHs. Please discuss.

17. Section 5.3, Surface Water Quality Summary

It is stated that where trace levels of BTEX compounds were detected, they were reported in similar levels in both the upstream and downstream samples. According to Table 5-10, this is incorrect in the case of benzene which was detected at trace levels at SW-1 and SW-2, and was not detected in upgradient locations SW-3 and SW-4. Revise.

18. Section 5.4, Page 5-11

Mention is made of direct evidence of reductive dechlorination from compounds in the degradation chain (i.e., daughter products). While the presence of cis-1,2 dichloroethene is indicative of degradation, the presence of tetrachloroethene and trichloroethene are not.

19. Section 5.4, Page 5-12, Last Bullet

Please provide further explanation to clarify and/or support the conclusions in this bullet. The last bullet asserts that natural attenuation of chlorinated compounds is hampered where they are co-eluted with the NAPL. Is the issue that conditions hamper degradation or that the NAPL serves as a long term continuing source of the chlorinated compounds such that even with robust degradation processes elevated levels of the chlorinated compounds will persist? The last bullet also asserts that natural attenuation appears to be occurring within the spatial and vertical fringes of the dissolved phase groundwater plume. Are these areas more favorable to degradation processes, or merely that the lack of a continuing source will result in reduced concentrations?

20. Conclusions

- a. While much (perhaps even most) groundwater contaminated by the site discharges to the River, the assertion in the first bullet that all the groundwater contaminated by the site discharges to the River is unsupported both because the full depth of the contamination has not been determined and the potential for some deeper groundwater to underflow the River has not been eliminated.
- b. The third bullet refers to the seeps representing the water bearing units at the site. The seeps certainly represent one of the water bearing units; it is unclear that they represent the only water bearing unit.
- c. The seventh bullet concludes that the NAPL is the primary source of groundwater impacts at the Site. The NAPL is the primary source for the PAHs and MAHs, and perhaps the BTEX. For the CVOCs, at most, the NAPLs are a secondary source because the contaminants have preferentially co-eluted into the NAPL.
- d. The ninth bullet discusses the location of impacted groundwater ("contained within Site boundaries"). Omitted is any discussion of the vertical extent of the impacted groundwater. Please discuss and include in the CSM what is known and assumed

about the vertical extent of impacted groundwater. Just as Figures 5-4 and 5-5 show the spatial extent of groundwater contamination, vertical cross sections should be provided that show the vertical distribution of contamination.

21. Figures 4-3, 4-4, 4-5, and 4-6

Figures 4-3, 4-4, 4-5, and 4-6 are cross sections illustrating the geological and hydrogeological features across the site. Is it possible to revise the figures so that the cross sections also indicate the actual interval screened by the monitoring wells? If so, please revise.


22. Table 5-1, Summary of Core Hole Data

Are the core holes identified in this table as CRS-K, CRS-I and CRS-J the same as CH-K, CH-I, and CH-J in the text and Figure 3.1?

23. Table 5-3, Summary of Fluid Saturations and Residual Saturations by Dean Stark Extraction
The Density columns have values reported as currency. Please revise.

We appreciate the Group's thorough work to date, and are glad to set up a call to talk about the work plan and comments soon. If you have any questions or concerns, please contact me at (312) 886-8961.

Sincerely,



Michelle Kerr
Remedial Project Manager

cc via email: L. Antonelli, OEPA
L. Vanderpool, USEPA
L. Mencin, Sherwin Williams
M. Watkins, B&C

CRS

LUANNE VANDERPOOL

to:

Michelle Kerr

12/11/2012 01:44 PM

Cc:

Larry Antonelli

Hide Details

From: LUANNE VANDERPOOL/R5/USEPA/US

To: Michelle Kerr/R5/USEPA/US@EPA,

Cc: Larry Antonelli <larry.antonelli@epa.state.oh.us>

History: This message has been replied to.

I thought I would let you know that I have reviewed the response to comments on the AGWS and am pretty happy!

There are 3 places where I might like minor changes to the AGWS.

These relate to 8b, 20b, and 20c.

8b: The response to comments explanation is fine; I would like to see some of that explanation added to the document.

20b: I don't think this is major, but I don't think that any of the seeps are surface expressions of the LBZ. Eg, the elevation of EBS1 is 688.5; The LBZ is defined as being below 667.

20c: I recommend adding to the revised text a phrase about the chlorinated solvent contamination being co-eluded in the NAPL. Hopefully this will not give anyone trouble, since it is consistent with the proposed new text being added in response to comment 16.

I am also assuming that the changes to figures and tables proposed in the response are acceptable (since the revised tables/figures were not provided).

Luanne Vanderpool

U. S. Environmental Protection Agency

Region 5, Superfund

77 W. Jackson, Chicago, IL 60604

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FAX: 312-582-5186

vanderpool.luanne@epa.gov



via overnight mail and electronically

December 14, 2012

Michelle Kerr
Remedial Project Manager
U.S EPA – Region 5
77 W. Jackson Blvd.
Mail Code: S-6J
Chicago, IL 60604-3590

**Re: Response to USEPA Comments Regarding Additional Groundwater Studies Report
United States of America v. AK Steel Corporation et. al.
Case No. 1:10-cv-00996-KMO
Chemical Recovery Systems Site, Elyria, Ohio**

Dear Ms. Kerr:


On October 9, 2012, Steerman Environmental Management & Consulting (“Steerman Environmental”), on behalf of the Chemical Recovery Systems, Inc. (“CRS”) Site Remedial Design/Remedial Action (“RD/RA”) Group Settling Performing Defendants (“Group”), submitted a draft Additional Groundwater Studies (“AGWS”) Report to U.S. EPA. In a letter dated November 15, 2012, U.S. EPA provided questions and comments on the draft report. CRS RD/RA Group consultants, Brown and Caldwell, Inc. (“Brown and Caldwell”) and EHS Support (“EHS”), reviewed U.S. EPA comments and prepared draft responses that were discussed during a December 12, 2012 conference call between U.S. EPA, CRS RD/RA Group members, Brown and Caldwell, EHS, and Steerman Environmental. Based on a discussion of the draft responses, and additional comments provided by U.S. EPA during the conference call, Brown and Caldwell prepared the attached response to U.S. EPA comments and the Final AGWS Report. A “red-line” version of the Final AGWS Report text, which highlights changes to the October 9, 2012 report, was provided to you electronically on December 13, 2012.

If you have any questions regarding the response to U.S. EPA comments or the revised AGWS Report, please feel free to contact the undersigned at (770) 992-2836, or by electronic message to psteerman@charter.net.



Steerman Environmental
Management & Consulting, LLC
422 Creek View Lane
Roswell, Georgia 30075
(404) 421-3275 - Voice
psteerman@charter.net

Best Regards,

A handwritten signature in black ink that reads "Patrick S. Steerman". The signature is written in a cursive, flowing style with a long horizontal line extending from the end of the name.

Patrick S. Steerman
CRS Site Project Coordinator

cc: Larry Antonelli, Ohio EPA (electronic copy)
Richard Karl, Director, Superfund Division EPA Region 5 (electronic copy)
Nigel Goulding, EHS Support (electronic copy)
Larry Mencin, CRS RD/RA Group, Technical Committee Chair, (electronic copy)
Doug McWilliams, CRS RD/RA Group Counsel
Tom Nash, Esq., U.S. EPA (electronic copy)
Mike Watkins, Brown & Caldwell (electronic copy)
CRS RD/RA Group



December 13, 2012

Patrick S. Steerman
Steerman Environmental Management & Consulting, LLC
422 Creek View Lane
Roswell, Georgia 30075

142766

Subject: Response to USEPA Comments on the Draft Additional Groundwater Studies (AGWS) Report
United States of America v. AK Steel Corporation et. al.
Case No. 1:10-cv-00996-KMO
Chemical Recovery Systems Site, Elyria, Ohio

Dear Mr. Steerman:

On October 9 2012, Steerman Environmental Management & Consulting submitted, on behalf of the Chemical Recovery Systems, Inc. (CRS) Site Remedial Design/Remedial Action (RD/RA) Group Settling Performing Defendants (Group), the Brown and Caldwell (BC) Draft Additional Groundwater Studies (AGWS) Report to the United States Environmental Protection Agency (USEPA) and the Ohio Environmental Protection Agency (OEPA). In a letter dated November 15, 2012, the USEPA provided questions and comments on the Draft AGWS Report. USEPA's comments are provided below and are followed by our proposed Group responses in italics.

1. Response to Comment #1 on Executive Summary, Page ES-2, First Paragraph and Section 4, Hydrogeologic Conceptual Site Model, Page 4-1, Second Paragraph

It is data that demonstrates and verifies conclusions which are incorporated into the CSM. The CSM simply summarizes what is known and assumed (or suspected) about the site.

Group Response:

The discussion of the CSM on pages ES-2 and 4-1 has been revised to indicate that the CSM is based on review and evaluation of Site data, and that it is the data, and not the CSM itself, that forms the basis of the conclusions drawn and presented in the report.

2. Response to Comment #2 on Investigative and Remedial History, Section 2.2

Absent from this history is any mention of the Record of Decision and the Consent Decree Statement of Work that provided the basis for undertaking the investigations that began in 2010. Please revise.

Group Response:

The ROD, CD and SOW are described in the first paragraph of the Executive Summary and in Section 1. Section 2 has been revised to include a similar discussion, along with how the ROD, CD and SOW relate to the investigative and remedial history presented in Section 2.2.

3. Response to Comment #3 on Monitoring Well Installation, Section 3.2.1

- a) The last bullet states "...the CSM clearly indicates that groundwater from the site discharges to the River...". This is a circular argument. The CSM summarizes the conclusion of the AGWS. It is results of the AGWS that indicate (or demonstrate) that groundwater from the site discharges to the River.
- b) The last bullet states "... groundwater from the site discharges to the River from both sides of the River". It is a minor misstatement to say that site groundwater discharges to the River from both sides of the river. Site groundwater discharges to the River on the east side of the river; groundwater on the west side of the river discharges to the river on the west side. Please revise.
- c) Please provide some explanation regarding the method of well development (airlift) used. Why was airlift used rather than surging and bailing? While the work plan does allow well development via airlift, it states that "in general most wells will be developed by using surge block and bailing". The work plan only describes development by using surge block and bailing in detail.
- d) Please provide rationale for the well depths and open borehole lengths of the new monitoring wells. Monitoring wells constructed during the remedial investigation have lengths of ten feet; several of the new monitoring wells constructed as part of the AGWS had substantially longer lengths (MW-10A at 22 feet, MW-12 at 30.5 feet, MW-I5A at 19 feet, MW-I5B at 15 feet). It is unclear why the longer lengths were used. If any vertical gradients are present, longer screens also allow cross- contamination as contaminants redistribute over the length of the screen due to vertical borehole flow. If vertical gradients are present, water levels measured in wells with longer screen lengths (e.g., greater than ten feet) are potentially ambiguous due to vertical flow in the borehole. Ideally, vertical gradients should be based on water levels measured in wells with short screens.

Group Response:

- a) *The last bullet in Section 3.2.1 has been revised to indicate that it is the data, and not the CSM itself, that indicate that groundwater from the Site discharges to the River.*
- b) *The last bullet in Section 3.2.1 has been clarified to indicate that groundwater discharges to the River from both sides of the River in the vicinity of the Site.*
- c) *The discussion of the well development method used has been expanded to include the rationale for using the method(s) selected. The wells were developed by airlift during installation since the air rotary drilling method was used for drilling and reaming. In addition, prior to sampling the new wells using low flow sampling methods, additional well development was performed using aggressive bailing methods to remove residual fine-grained material. Completed well development forms for this supplemental well development are included in Appendix A to the report. The surge block method is typically used for wells with filter/sand packs around the screened interval in order to mobilize and remove fine grained material from the filter/sand pack. However, because the wells installed during the AGWS were "open rock" wells, filter/sand packs were not used and the groundwater expelled from the wells "cleared" during drilling.*

- d) *The monitoring wells installed during the AGWS were designed to serve several purposes. These purposes included bedrock stratigraphy evaluation using rock coring, packer testing, groundwater sampling, and water level acquisition. The primary goal in 2011 was to define the shale/bedrock interface, and installing wells in each bedrock unit per the SOW. After coring, it was discovered that the shale unit cited in earlier reports was not present at the suggested depths.*

The effective open/screened intervals of these wells are best measured from the groundwater level to the bottom of the borehole, instead of the total open rock interval. This reduces the "screen length" of the cited wells from 22 feet to 15 feet (MW-10A), from 30.5 feet to 21.5 feet (MW-12), and from 19 feet to 12 feet (MW-15A). With the exception of MW-15B, the remaining effective lengths are 10 feet or less. While it's true that shorter lengths are desirable for the reasons cited, water level data indicates that the vertical gradient at the site is fairly low, and that the potentiometric level in deeper groundwater is higher than the surface level of the river. The lengths of the wells do not significantly affect the potentiometric surface maps or interpretations presented in the report. In addition, due to the proximity of the Site to the local discharge point for the UBZ and LBZ, small vertical gradients would be expected. A paragraph has been added to 3.2.1 to clarify this issue in the Report.

4. Response to Comment #4 on Downhole Geophysical Logging, Section 3.2.6, Page 3-5

Mention is made of the heat-pulse flowmeter being used. Where are the results of this testing? Did this testing provide any useful information?

Group Response:

Although use of the heat-pulse flowmeter was considered for use at the Site, it was not selected for use due to the relatively short-length open-interval wells being installed. It was felt that the heat-pulse flowmeter would be of little value under those circumstances. The suite of downhole geophysical tools used during the AGWS consisted of natural gamma ray, spontaneous potential, single-point resistivity, fluid resistivity, temperature, and caliper. Section 3.2.6 has been revised to provide descriptions of the full suite of geophysical tools used.

5. Response to Comment #5 on Section 3.3.4, Permeability Testing of Bedrock and Appendix J

Please explain the significance of the yellow highlighted values in the table of packer test results in Appendix J.

Group Response:

Section 3.3.4 and Appendix J have been revised to indicate that the yellow highlighted hydraulic conductivity values indicated on the summary table in Appendix J are the representative values for each interval tested. Where more than one test was run for a given interval, the value from the last test was generally considered to be most representative for that interval because by that test any discontinuous voids/fractures had likely been filled with the test water and the resulting measurements were representative of in situ conditions.

6. Response to Comment #6 on Section 4, Hydrogeologic Conceptual Site Model, Page 4-1, Bullet #1

It is stated that the base of the River extends some 15 feet below the elevation of groundwater on the site. This is inaccurate. Perhaps the authors meant that the base of the River is below the level of the potentiometric surface of the groundwater at the site. There certainly is groundwater at the site found at depths lower than the base of the river. Please revise or clarify.

Group Response:

The first bullet on Page 4-1 has been clarified to indicate that the base of the River is 15 feet below the potentiometric surface of the shallow groundwater at the Site.

7. Response to Comment #7 on Section 4, Hydrogeologic Conceptual Site Model, Page 4-1, Bullet #3

It is concluded that groundwater discharges to the River. We agree with the conclusion that groundwater under the site discharges to the river. But it is unknown if all of the groundwater underneath the site discharges to the River, since groundwater extends much deeper than was investigated. It is common for deeper groundwater near a small river to underflow the river, moving consistent with the regional groundwater flow pattern even as the shallower groundwater is discharging into the river. To conclude that all groundwater discharges to the river, deeper horizons would need to have been investigated. Given the conceptualization (stated in the first paragraph of Section 4.1.3) that horizontal groundwater flow is predominantly controlled by laterally extensive bedding plane fractures, it is unclear what would be the mechanism for upward vertical flow of groundwater located in the bedrock at elevations lower than the base of the river. A more accurate (and nuanced) conclusion is that groundwater in the upper portion of the bedrock discharges to the River (and that most contamination is found in the upper portions of the bedrock). Discuss and revise.

Group Response:

The third bullet on Page 4-1 has been clarified to indicate that both the UBZ and LBZ groundwater at the Site discharges to the River, rather than using the generic terms "shallow" and "deeper". Section 4.1.2 has been revised to acknowledge that deep groundwater beneath the Site, and beneath the impacted groundwater zones at the Site, may not discharge to the River in favor of following the regional groundwater flow pattern.

8. Response to Comment #8 on Section 4.1.2, Groundwater Elevation and Flow, Page 4-2

- a) Please provide some discussion of regional groundwater flow.
- b) Discussion of the separation of the investigated bedrock into two zones, the Upper Bedrock Zone and the Lower Bedrock Zone (LBZ), would be facilitated by a reference to Table 4-2, which shows the zone each well has been assigned. According to the text, the LBZ is monitored by wells with screened intervals below 667ft., msl. According to Table 4-2, MW-15B is classified as LBZ, but is screened from 679.8 ft., msl to 664.9 ft., msl. Only 2.1 feet of the 15 foot screened interval is below 667 ft., msl. Please explain.

Group Response:

- a) *Section 2.3 has been expanded to include a discussion of regional ground-water flow in the vicinity of the Site. A bullet has been added to Section 4.1.2 that briefly discusses regional groundwater flow, including reference to Section 2.3.*
- b) *Reference to Table 4-2 is now made earlier in Section 4.1.2. The selected elevation of ± 667 ft, msl to differentiate between the UBZ and LBZ is not based on a well-defined lithologic or other physical distinction, as indicated in the report. This distinction has been made to allow for a better evaluation of groundwater elevation and groundwater quality data with respect to understanding the horizontal and vertical flow patterns and distribution of constituents, and to provide a means of comparing data at well couplets that consist of two wells screened at different depths. The fact that only a small portion of the open interval of well MW-15B is below the threshold elevation of 667 ft, msl has little effect on the intent of making the distinction between the data from the UBZ well coupled with it, MW-15A, or other UBZ wells at the Site. Section 4.1.2 has been revised to indicate that the threshold elevation of ± 667 ft, msl is a generalized threshold.*

9. Response to Comment #9 on Section 4.1.2, Groundwater Elevation and Flow, Page 4-3

- a) Of the four rounds of water levels obtained, two were collected less than a week apart in time (6/14/12 and 6/19/12). What was the rationale for collecting water levels less than a week apart?
- b) Mention is made of downhole geophysical logging and it is stated that the logs are summarized in Table 4-1. Were any general conclusions drawn from the logging? Please summarize relevant conclusions in the text. Section 4.1.3 alludes to potential water bearing fractures identified on the geophysical logs.
- c) Did the heat-pulse flowmeter testing provide any insights?
- d) Mention is made of hydraulic conductivity packer testing and it is stated that the results are summarized in Table 4-3. Please add a reference to Section 4.1.3, which discusses the results.

Group Response:

- a) *A complete round of water levels was collected on 6/19/12 in order to include the elevation of the water within the manhole on Locust Street. The temporary stilling well installed in the manhole was not available during the earlier round of water levels collected on 6/14/12. A footnote has been added to the Report to explain this decision.*
- b) *Section 4.1.2 has been expanded to provide more details regarding interpretation of the geophysical logs and comparison to corehole physical descriptions in the boring logs*
- c) *See the Group Response to Comment No. 4.*
- d) *A reference to Section 4.1.3 for a detailed discussion of the packer testing results has been added to the third bullet on Page 4-3.*

10. Response to Comment #10 on Section 4.1.2, Groundwater Elevation and Flow, Page 4-4

- a) In the first bullet, it is stated that there is a distinct downward gradient across most of the site with the gradient decreasing as the River is approached. On what is this conclusion based? There are five well nests at which vertical gradients can be determined; please provide a table listing the calculated gradients to help support the stated conclusion.
- b) Please acknowledge that in some cases water levels were measured in monitoring wells with long (greater than ten feet) screened intervals. Monitoring wells with long screen intervals may have vertical mixing due to flow in the borehole, resulting in ambiguous water level measurements.
- c) In the fifth bullet, it is stated that water levels in the wells responded more slowly and gradually to rain events. More slowly than what, the River, the storm sewer, etc?.
- d) In the sixth bullet the River elevation levels are discussed. Consider if this discussion is a better fit in Section 4.2, River Stage.

Group Response:

- a) *The observation stated in this bullet is based on a qualitative review of the hydrographs for well couplets MW-6RA/C, MW-7A/D, MW-10A/B, 11A/B and 15A/B since the hydrographs represent continual measurements over time. A new table, Table 4-4, has been created that indicates the vertical gradients for the well couplets based on the two rounds of water levels obtained during the AGWS investigation. The discussion in Section 4.1.2 has been revised based on review of the data.*
- b) *A discussion regarding the open/screened intervals has been added to Section 3.2.1.*
- c) *The fifth bullet on Page 4-4 has been revised to indicate that the water levels in wells responded more slowly and gradually than the River level and Manhole water level.*
- d) *The discussion of the River level response to precipitation events has been reiterated in Section 4.2.*

11. Response to Comment #11 on Section 4.1.3, Aquifer Transmissivity and Groundwater Flux

- a) It is implied that the fractured bedrock system at this site behaves as a porous media equivalent. What is the basis for this assumption? How frequent are the horizontal bedding planes? Is this an equivalent porous system or a dual porosity system?
- b) Needed is a clear and consistent conceptualization of the flow regime at the site. The text implies that the horizontal flow at the site is predominantly controlled by laterally extensive bedding plane fractures. The slides prepared for the 11/18/12 teleconference/meeting included a slide "Hydro-Geological Conceptual Site Model" (#5) that includes the statement that Groundwater flow is "primarily through the inter- granular porosity of the rock". Please discuss.
- c) During the Data Review teleconference/meeting on 9/17/12, a distinction was made (slide #13) between hydraulic conductivity in the unfractured rock (i.e. due to primary porosity of the massive bedrock) and the hydraulic conductivity

of the bedding fracture zones. This conclusion was not articulated in the AGWS. Was this a conclusion of the packer testing and logging (and should be added to the AGWS) or did further analysis negate this conclusion?

Group Response:

a) *Shallow groundwater at the Site flows through both the rock matrix and bedding plane fractures. The packer testing indicated hydraulic conductivity differences approximately 1-2 orders of magnitude less for the rock matrix versus the fracture zones, however, due to the nature of the bedrock (connected inter-granular porosity, etc.), significant groundwater flow through the rock matrix occurs, although preferential fluid movement is through the more permeable bedding plane fractures. For bedrock flow systems with the upper portion of the Berea Sandstone present beneath the Site, it is both common and appropriate to treat the system as a porous and permeable medium. This is applicable to the Site based on the following:*

- Horizontal bedding fractures are relatively abundant and with small apertures;*
- There is a relatively small difference, generally less than two orders of magnitude, in hydraulically conductivity between the fractures and rock matrix; and*
- There are no impediments to vertical flow within the system.*

Although there are certainly differences in hydraulic conductivity between the bedding plane fractures and the rock matrix which must be acknowledged, the approach used to calculate groundwater flux to the River over the short distances involved at the Site is considered to be appropriate and consistent with standard industry practice.

To account for the observed differences in hydraulic conductivity obtained from the packer testing, the system at the Site was divided into three intervals for calculating groundwater flux to the River. The geometric mean of the hydraulic conductivity values within each interval was assigned to that interval. For each interval, the range of the observed hydraulic conductivities was on the order of an order of magnitude.

b) *See Group Response to Comment #11a.*

c) *See Group Response to Comment #11a.*

12. Response to Comment #12 on Section 4.2, River Stage

Reference is made to "Site-specific River elevations shown on the hydrographs". Please explicitly cite the relevant figure(s).

Group Response:

The hydrographs indicating the river elevation are Figures 4-11, 12, 14, 15 and 16. A reference to these figures has been added to the last paragraph in Section 4.2.

13. Response to Comment #13 on Section 5.1.1, NAPL Distribution and Occurrence and Table 5-1

- a) Please explain in the text (if correct), that if there is not mention of a well/borehole in Table 5-1, that there were no observations related to non-aqueous phase liquid (NAPL, perhaps even explicitly listing the wells/boreholes with no evidence of NAPLs).
- b) Elevated soil vapor concentrations may be indicative of dense non-aqueous phase liquid (DNAPL). What is the basis/rationale for assuming that a greater than 100 ppmv soil vapor reading is indicative of DNAPL?

Group Response:

- a) *Table 5-1 lists only those coreholes/wells that indicated physical evidence of NAPL. Section 5.1.1 has been revised to include this statement, in addition to a footnote to this effect on Table 5-1.*
- b) *The 100 ppm_v was a screening level developed by Brown and Caldwell as an indication of “indirect” evidence for the likely presence of NAPL. The 100 ppm_v level was selected because it was at the low end of the concentration range observed when deeper soils within the borehole had other physical evidence of NAPL, such as staining and modest to strong chemical odor. Section 5.1.1 has been revised to include this explanation.*

14. Response to Comment #14 on Section 5.2, Groundwater Quality Summary, Page 5-9, Last paragraph

The text states that U.S. EPA guidance has indicated that groundwater with concentrations of 1% of the effective solubility of a compound (the 1% rule) may be indicative of a NAPL source. To be clear, the “1% rule” indicates that the groundwater sampled may have come in contact with the NAPL at some point; it is not definitive regarding distance to the NAPL. Thus, it is indicative of NAPL somewhere upgradient of the groundwater sampled. Please clarify.

Group Response:

Section 5.2 has been clarified to indicate that groundwater concentrations that exceed 1% of the effective solubility limit are indicative of a likely NAPL source upgradient or in the vicinity of the well where the concentration was measured.

15. Response to Comment #15 on Section 5.2, Groundwater Quality Summary, Page 5-10, Second Paragraph

MW-6RA, MW-6RB, MW-6RC were intended to evaluate vertical distribution of contaminants at MW-6. This demonstration would have been more effective had the screened lengths of MW-6RA and MW-6RB not overlapped. It is stated that that MW-6RA and MW-6RB are screened at higher elevations than MW-6. This is true by mere inches. MW-6 is screened from 700.2 ft., msl to 690.2 ft., msl. MW-6RA is screened from 700.9 ft., msl to 695.9 ft., msl. This is basically the

top half of MW-6's screen (the top of MW-6RA's screen is only 0.7 feet higher than MW-6). MW-6RB is screened from 700.5 ft., msl to 691.5 ft., msl. This is nearly identical to MW-6; the top of screen is 0.3 feet higher and the bottom of the screen is 1.3 feet higher than MW-6. It is likely that the higher levels detected in MW-6 compared to MW-6RB are more indicative of lateral variability rather than vertical variability of contaminant concentrations. Please discuss.

Group Response:

The below discussion has been included in Section 5.2.

Three additional wells (MW-6RA, MW-6RB and MW-6RC) were installed immediately downgradient of existing well MW-6 to evaluate the vertical distribution of contaminants in groundwater at MW-6 and to confirm that MW-6 is screened in the zone of greatest impact. Wells MW-6RA, MW-6RB and MW-6RC were installed in a line approximately 12 feet west from MW-6. Based on the physical characteristics of the Site and subsurface, these new wells were also considered to be downgradient, down slope and down dip from MW-6, and as such would be in the path of former NAPL migration, if any. The depths of the wells were determined in the field based on the presence or absence of NAPL observed during drilling, while being careful to not provide an avenue for cross-contamination during drilling. The analytical results for wells MW-6 and MW-6RB are similar, as expected, since these two wells are screened at similar elevations. Well MW-6RA is screened across the approximate upper half of the zone screened by MW-6 and MW-6RB, while the top of the screened interval for MW-6RC is approximately 2-3 feet below the bottom of the screened intervals of MW-6 and MW-6RB, providing distinct monitoring separation. The total VOC concentrations measured in MW-6RA and MW-6RC were 3-4 times lower than those measured in MW-6 and MW-6RB, confirming that MW-6 is screened in the zone of greatest impact in the area of these wells.

16. Response to Comment #16 on Section 5.2, Groundwater Quality Summary, Page 5-10, Second Bullet

It is stated that the NAPL is the primary source of groundwater impacts. This may be true for BTEX (Benzene, Toluene, Ethylbenzene and Toluene), MAHs (Mono-Cyclic Aromatic Hydrocarbons), and PAHs (Poly-Cyclic Aromatic Hydrocarbons). It seems less true for CVOCs (Chlorinated Volatile Organic Compounds). According to Section 5.1.5.1, the compounds detected in the NAPLs were primarily MAHs and PAHs. Please discuss.

Group Response:

The below discussion has been included in Section 5.2.

The NAPL analytical testing data indicate that chlorinated compounds are present within the NAPL at high concentrations. These compounds have become co-eluted within the NAPL and in addition to the MAHs and PAHs are long-term sources of impacts to groundwater at the Site. As shown in Table 5-8, the effective solubilities of chlorinated compounds in the NAPL are high compared to other compounds. For example calculated effective solubilities for TCE and cis 1,2 DCE were 34,000 µg/L and 105,000

µg/L, respectively. These concentrations are over 3 orders of magnitude higher than in locations outside the NAPL impacted area (including the wells located hydraulically down-gradient of the NAPL). Based on the NAPL being located within the saturated zone, its high effective solubility and the lateral distribution of NAPL (that potentially takes up greater than 50% of the Site), the NAPL is considered the major ongoing source of chlorinated constituents in groundwater.

This observation is further supported by the groundwater monitoring data, which demonstrate that the highest concentrations of chlorinated compounds are located within and hydraulically downgradient of the area of NAPL impacts. Groundwater monitoring wells MW-12, MW-11A and MW-11B are all located hydraulically down-gradient of the NAPL impacted areas. Groundwater samples from well MW-12, immediately downgradient of the NAPL, has order of magnitude higher dissolved concentrations than wells that are unaffected by the NAPL (e.g., wells MW-1, MW-5 and MW-9D). Further, the groundwater samples collected within the NAPL impacted areas (and likely affected by NAPL) have concentrations of chlorinated compounds three orders of magnitude higher than was detected elsewhere on the Site.

17. Response to Comment #17 on Section 5.3, Surface Water Quality

Summary

It is stated that where trace levels of BTEX compounds were detected, they were reported in similar levels in both the upstream and downstream samples. According to Table 5-10, this is incorrect in the case of benzene which was detected at trace levels at SW-1 and SW-2, and was not detected in upgradient locations SW-3 and SW-4. Revise.

Group Response:

Section 5.3 has been revised to provide clarification regarding the trace detection of benzene during the second round of surface water sampling.

18. Response to Comment #18 on Section 5.4, Page 5-11

Mention is made of direct evidence of reductive dechlorination from compounds in the degradation chain (i.e., daughter products). While the presence of cis-1,2 dichloroethene is indicative of degradation, the presence of tetrachloroethene and trichloroethene are not.

Group Response:

Section 5.4 has been revised to indicate that at this Site PCE and TCE are likely the parent compounds, while compounds such as cis 1,2-DCE, 1,1-DCE and vinyl chloride are the daughter products. This section has also been expanded to include the below discussion.

Biodegradation of both hydrocarbons and chlorinated compounds is observed hydraulically downgradient of the NAPL source(s). Along the groundwater transect which extends from the source area through MW-12 to the MW-11 couplet at the boundary of the Site, major reductions in dissolved hydrocarbon and chlorinated concentrations are observed in groundwater. Table 5-11 provides relevant compounds and observed concentrations along this transect. In addition,

direct evidence of reductive chlorination is observed with the degradation of parent products and the production (or retention of higher concentrations) of daughter products. These indicators include the formation of 1,1-dichloroethane (1,1 DCA), 1,1-dichloroethene (1,1 DCE) and chloroethane as degradation products of trichloroethene (TCE), 1,1,1-trichloroethane (1,1,1-TCA) and cis 1,2 DCE degradation, respectively and the major declines in concentration of TCE and cis 1,2 DCE.

19. Response to Comment #19 on Section 5.4, Page 5-12, Last Bullet

Please provide further explanation to clarify and/or support the conclusions in this bullet. The last bullet asserts that natural attenuation of chlorinated compounds is hampered where they are co-eluted with the NAPL. Is the issue that conditions hamper degradation or that the NAPL serves as a long term continuing source of the chlorinated compounds such that even with robust degradation processes elevated levels of the chlorinated compounds will persist? The last bullet also asserts that natural attenuation appears to be occurring within the spatial and vertical fringes of the dissolved phase groundwater plume. Are these areas more favorable to degradation processes, or merely that the lack of a continuing source will result in reduced concentrations?

Group Response:

The referenced bullet has been revised, and another bullet added, based on the following.

Biodegradation of chlorinated compounds is not hampered by the presence of NAPL, rather the reducing conditions and the presence of co-metabolites is enhancing the reductive dechlorination and co-metabolic degradation of these chlorinated compounds. The presence of NAPL, however is an ongoing and continuous source of dissolution of chlorinated compounds to groundwater, and as a result the presence of elevated concentrations of both chlorinated and non-chlorinated compounds in groundwater will persist.

Assessment of the ORP/Redox conditions within groundwater indicates that reducing conditions are prevalent in groundwater within and immediately down-gradient of the NAPL source(s). These conditions are the most conducive to reductive de-chlorination and evidence of sequential decay is observed in both major declines in contaminant concentrations and the presence of multiple daughter products along the dechlorination chain (see Group Response to Comment #18).

20. Response to Comment #20 on Conclusions

- a) While much (perhaps even most) groundwater contaminated by the site discharges to the River, the assertion in the first bullet that all the groundwater contaminated by the site discharges to the River is unsupported both because the full depth of the contamination has not been determined and the potential for some deeper groundwater to underflow the River has not been eliminated.
- b) The third bullet refers to the seeps representing the water bearing units at the site. The seeps certainly represent one of the water bearing units; it is unclear that they represent the only water bearing unit.
- c) The seventh bullet concludes that the NAPL is the primary source of groundwater impacts at the Site. The NAPL is the primary source for the PAHs and

MAHs, and perhaps the BTEX. For the CVOCs, at most, the NAPLs are a secondary source because the contaminants have preferentially co-eluted into the NAPL.

- d) The ninth bullet discusses the location of impacted groundwater ("contained within Site boundaries"). Omitted is any discussion of the vertical extent of the impacted groundwater. Please discuss and include in the CSM what is known and assumed about the vertical extent of impacted groundwater. Just as Figures 5-4 and 5-5 show the spatial extent of groundwater contamination, vertical cross sections should be provided that show the vertical distribution of contamination.

Group Response:

- a) *The first bullet in the Conclusions has been revised to indicate that groundwater within the UBZ and LBZ at the Site discharges to the River. As the Group Response to Comment No. 7 indicates, we will acknowledge that groundwater at depth beneath the Site likely assumes the regional flow pattern and its flow may not be affected by the River.*
- b) *The third bullet in the Conclusions has been clarified to indicate that the seeps represent surface expressions of the "shallow" water bearing units adjacent to the River at the Site, and specifically the UBZ and LBZ.*
- c) *As noted in the Group Response to Comment #16, the Group does consider the NAPL to be the main ongoing source of chlorinated impacts to groundwater in the southern and central areas of the Site. In the northern portion of the site, near wells MW-1 and MW-9D, where the concentrations of chlorinated constituents are lower, the source of chlorinated impacts to groundwater is not the NAPL. This distinction has been made in the Conclusions.*
- d) *The discussion in Section 5-2 of the vertical extent of groundwater impact at the Site has been expanded to include the projected vertical limit of impact beneath the Site. The analytical data boxes shown on Figure 5-4 have also been included on the cross sections (Figures 4-3, 4-4, 4-5 and 4-6) for the wells shown. The ninth bullet in the Conclusions has been expanded to include both the horizontal and vertical extent of impacted groundwater.*

21. Response to Comment #21 on Figures 4-3,4-4,4-5, and 4-6

Figures 4-3, 4-4, 4-5, and 4-6 are cross sections illustrating the geological and hydrogeological features across the site. Is it possible to revise the figures so that the cross sections also indicate the actual interval screened by the monitoring wells? If so, please revise.

Group Response:

The open rock/screened intervals have been designated on Figures 4-3 through 4-6. The protective casing symbol has also been added to the legends on these figures for clarification.

22. Response to Comment #22 on Table 5-1, Summary of Core Hole Data

Are the core holes identified in this table as CRS-K, CRS-I and CRS-T the same as CH-K, CH-I, and CH-J in the text and Figure 3.1?

Group Response:

Table 5-1 has been revised to change the coreholes previously identified as "CRS" to "CH".

23. Response to Comment #23 on Table 5-3, Summary of Fluid Saturations and Residual Saturations by Dean Stark Extraction

The Density columns have values reported as currency. Please revise.

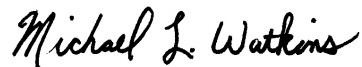
Group Response:

The "Density" column in Table 5-3 has been revised accordingly.

Please contact me at 216-606-1309 if you have any questions regarding the responses provided above or the redlined changes/additions made to the attached Revised AGWS Report.

Sincerely,

Brown and Caldwell



Michael Watkins, P.G.
Project Manager

cc via email:

Enclosures:



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 5
77 WEST JACKSON BOULEVARD
CHICAGO, IL 60604-3590

SR-6J

December 20, 2012

REPLY TO THE ATTENTION OF:

Mr. Patrick Steerman
Steerman Environmental Management & Consulting, LLC
422 Creek View Lane
Roswell, GA 30075

Re: Chemical Recovery Systems Inc. Site
Additional Groundwater Studies Report Approval

Dear Mr. Steerman:

On October 9, 2012, the U.S. Environmental Protection Agency (EPA) and Ohio Environmental Protection Agency (OEPA) received the Additional Groundwater Studies draft report, from you, representing the Chemical Recovery Systems Remedial Design/Remedial Action Group Performing Parties (CRS Group). The Agencies commented on the report on November 15, 2012, and after a meeting on December 12, 2012, CRS Group submitted responses to those comments and a revised report on December 14, 2012. EPA accepts the revised Additional Groundwater Studies Reported as submitted.

We recognize and appreciate the thorough, high quality technical work reflected in the report and value its fundamental role in forming an appropriate conceptual model for the site. If you have any questions or concerns, please contact me at (312) 886-8961.

Sincerely,

A handwritten signature in black ink, which appears to read "Michelle Kerr", is positioned above the printed name.

Michelle Kerr
Remedial Project Manager

cc via email: L. Antonelli, OEPA
L. Mencin, Sherwin Williams
M. Watkins, B&C
L. Vanderpool, EPA